Herbert Halliday

OPHTHALMIC SURGERY

BEARD

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A TREATISE ON SURGICAL OPERATIONS PERTAINING TO THE EYE AND ITS APPENDAGES, WITH CHAPTERS ON PARA-OPERATIVE TECHNIC AND MANAGEMENT OF INSTRUMENTS

BY

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PREFACE.

The selection of the matters discussed in the following pages and the manner of treating them are the results of the careful study and practical application of the involved principles made in hospitals, dispensaries, and in private practice, extending over a period of twenty-six years. They began while the author was a student under Agnew and Knapp, in 1883, were later continued in England and on the Continent of Europe, and have ever since been diligently prosecuted.

There has been no separate work on the surgery of the eye published in the United States for nearly half a century, and but little written upon the subject in connection with the more general treatises on ophthalmology, if we except the admirable contribution of Knapp to the System of Norris and Oliver some twelve years ago. The object here has been to supply a work that would embody not only what experience has taught and judgment prompted as being the more valued measures of all countries, but, in particular, those of our own country.

The presentation of portions devoted to the history of the different procedures is deemed of great importance, but to keep them from appearing obtrusive they have been made as concise as practicable.

The classification followed has seemed the logical one to adopt. The chapter on the extraction of foreign bodies from the interior of the eye has been placed in a class of its own instead of with the operations upon the globe. In the author's opinion, the

handling of foreign bodies in the eye is a subject apart, the methods employed in their diagnosis, localization, and extraction involving so much that is not in line with other branches of ophthalmic surgery.

In view of the fact that the illustrations have been chiefly the fruits of his individual labor, the writer begs his confrères not to consider them in the light of mere pictures or from the standpoint of artists, but as conceptions of how these things should appear by one with considerable experience in the matters depicted and with a little facility in the power of delineation.

In closing, the author offers his sincere thanks to all others who have been instrumental in supplying whatever of merit this volume contains.

CHARLES H. BEARD.

Chicago, 1910.

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OPHTHALMIC SURGERY.

CHAPTER I.

PARA-OPERATIVE TECHNIC.

Asepsis.—According to Snellen, all wounds, especially those of the eye, tend to heal *per primam intentionem*, and it is gratifying to know that the work of the ophthalmic surgeon has made good this assertion. While it is true that this branch of surgery has seemed to profit more than the others by antiseptic measures, yet, when we consider the status of our knowledge of the value and of the means of asepsis, our operative results are a reproach. The fact remains that the vast majority of untoward consequences are due to some form of infection. Thus the advantage is still on the side of the operator who is most thorough and consistent in carrying out antiseptic precautions, rather than on the side of mere skill. Lack of these precautions oft turns into abject failure the most brilliantly executed surgical measure, while attention to them can make a perfect triumph of a wretched bungle. We are in constant need not only of an "antiseptic conscience," but of an aseptic subconsciousness as well. We should acquire a habit of surgical cleanliness and try to impart it to everybody about us. Unless one is broadly grounded in this training, he is being forever the victim of his own anti-climaxes, as, for example, picking his teeth with his finger-nail, scratching his head, or taking an instrument between his lips just after having made the most elaborate and up-to-date preparation for an operation. With some of the older ones the genuine habit is difficult—at times impossible—to attain. With the younger ones it should be easy.

The key-note to asepsis is *sterilization*. This is of two kinds, *relative* and *absolute*. The first refers to the preparation of the hands and persons of surgeons, attendants, patients, and of the

parts concerned in the proposed surgical measure. The second is applicable only to inanimate objects, such as instruments, articles used in making applications, the materials for dressings, etc. Obviously vital animal tissue cannot be subjected to this form of sterilization Therefore, in the use of purifying solutions upon it, one is inclined to make up in abundance what is lacking in strength.

Preparation of the Hands and Forearms.—It is well to include the hands and arms of the patient as well as those of the operator and all of his aids in this process. They are first scrubbed with good soap, liquid or solid, and tepid water, by means of a brush that is not too stiff. The nails are trimmed, cleaned and scrubbed with the brush. The hands are then rinsed with pure warm water, using the brush. After drying on a sterile towel, they may now be anointed with a mixture of alcohol, glycerin, and one of the highly antiseptic essential oils, as that of cloves or of cinnamon, to be immediately followed by a good rubbing. This has the property of great penetration, entering into the ducts of the sweat and sebaceous glands, and permeating the deeper layers of epithelial masses. Lastly, they are washed lightly in sterile water and wiped perfectly dry on a sterile towel. Allowing the hands to dry spontaneously is not so cleanly, as the moisture catches dust. The oft-repeated washing of the hands with solutions of irritating antiseptics like sublimate, formalin, and carbolic acid has the effect of making them sore, and rough with dead epidermis, without in the least rendering them less infectious. A soap impregnated with a grinding material is excellent for hands that are inclined to be rough.

Gloves.—The more important and exacting operations upon the eye are performed without the surgeon's fingers ever coming in contact with the field of operation. Hence, the wearing of rubber gloves on his part would be not only uncalled for, but when the extreme exactness of most opthalmic surgery is considered, positively unadvised. For all of his assistants, however, to wear them, were both prudent and desirable. Especially is this true as regards those who make and handle the cotton sponges, or thread, or any object that actually touches the site of operation.

Sterilization of Instruments.—There are three methods more or less in use for this purpose, that *by dry heat*, that *by moist heat*, and that *by strong antiseptics*. It need hardly be said that this

proceeding takes place immediately before the operation. When prepared **by dry heat** the instruments are put into some form of stove or oven, of which there are many efficient kinds on the market. Here they are exposed for twenty minutes, or longer, to a tempërature of 300° F. This is applicable to all kinds of instruments, even to those with ivory handles. In winter, or in very moist weather, the door of the oven is left open for a few moments after the heat is started, in order to prevent the quick corrosion of fine edges and points that comes from condensation. Sterilizing in a flame is fatal to any instrument.

By Moist Heat.—It is customary to put in this class sterilization by means of live steam, in an autoclave, under pressure. In reality, if carried out to the letter, this is a form of dry sterilization. In this country eye instruments are rarely subjected to this process. The method most in vogue, and most to be recommended is by boiling. Contrary to many adverse statements and comments, I believe this method the best for all kinds of eye instruments. That is, just as appropriate as any for the finer cutting implements. True the instruments must be manufactured with a view to being so treated. They must have metal handles—be *all* of metal, in fact, and the procedure must be conducted by one who knows and does full duty in the matter. I cannot do better than give a description of it as practised in the Illinois Eye and Ear Infirmary. All the more delicate instruments are placed in a metal rack, provided with a handle and with a clamp which holds them securely, the points and edges of the sharp ones having been previously tested on the trial-kid. The rack projects beyond the extremities of the instruments so that they cannot be jammed against the boiler. There is a separate compartment in the boiler for this rack. The coarser and non-cutting articles are dropped carefully into another compartment. The boiler contains a solution of soda or borax, one to two parts per thousand. The presence of the salt serves to elevate the degree of ebullition and to restrain oxidation. The solution is perfect—i.e., there must be none of the salt undissolved. The instruments are not put in until the water reaches the boiling-point. Of course the boiling ceases the moment they are immersed. One waits, then, until it begins again before starting to time the sterilization. The time should not be less than ten minutes.

Fifteen would not be too long. The instruments are then lifted out drained, and laid on sterile towels on the trays of the serving tables. It would be well to have a small oven in which to dry them quickly just before using. The plan, so generally followed, of putting them fresh from the boiler into some liquid, there to remain till used, is not consistent with good surgery. It is not pleasant to either operator or operated to have water dropping into the eye from the instruments; besides, since the sterilization of the hands is only relative, infection could in this way, be carried from the fingers into the wounds. If promptly dried the moment they are removed from the sterilizer one need have no apprehension as to the points and edges of the finest knives. If left in the air, covered with moisture, oxidation becomes at once very active, and it is precisely the thin edges and sharp points that will suffer most. All sutures are boiled ready threaded in their needles. If to be treated with paraffin, or other waxy material, this is best put on afterward, as the considerable handling necessitated by the threading is apt to contaminate the suture.

By Strong Antiseptics.—This is the least satisfactory method, and must ever be one of expedition, not of choice. It consists in letting the instruments lie for 15 minutes or longer in a bath of one of several liquids. The commoner are 40% formalin, 95% phenol, 95% alcohol, and pure chloroform. They are then taken out and washed in sterile water. This is an uncertain process, for if there be the thinnest possible film of any fatty or albuminous substance on the instrument it acts as a barrier to disinfection. Moreover, all these fluids attack the steel with some degree of activity. This form of sterilization is made much surer by wiping the instruments repeatedly, and *hard*, with sterile, soft linen just before putting them into the bath. If done intelligently, this also enhances the polish and the keenness of the trenchant articles wiped. It is not a bad idea to have the cloth wet with the antiseptic. It was the practice of Agnew, of New York, to wipe his Graefe knife long and hard with soft linen, before the days of antisepsis, to render it *cleaner*, *brighter* and *sharper*.

Preparation of the Patient.—This is divided into *general* and *local*. General preparation is of two kinds, *physical* and *mental*. General preparation may be begun at an indefinite time previous

to the operation, and should never, in case of major operations, be started less than 24 hours previously. First, on entering the hospital come the taking of the histories, family, personal, and clinical, then the physical examinations, general and local. These include urinalysis, inquiry into the state of circulatory and vascular systems (if subject is not young), nose, throat, lungs, heart, digestion, etc. The bowels are emptied by broken doses of calomel followed by citrate of magnesia or salts, or by castor oil. The diet is liquid or very light. If the operation is to be under narcosis, or if the subject is nervous or apprehensive, it is well to give a small dose of morphin, or chloretone, or bromid of sodium, thirty to forty minutes before the start for the surgical room. The patient is questioned as to cough, and, if general anesthesia is contemplated, as to behavior in any former narcosis. Both eyes and their appendages are thoroughly examined and the results recorded. Particular care is directed to the condition of the pupils, the fundi, the cornea, the conjunctiva and the lacrimal canals. Bacteriologic investigation of even the healthy appearing conjunctiva is of positive advantage in that an incipient pathogenic or pyogenic infection may be discovered and disaster averted by a postponement of the proposed operation. The vision, the refraction, fields, etc., are noted. The subject must be made as clean as possible, but it is best to leave it to the discretion of a trained attendant whether or not regular tub bathing and shampooing be resorted to. Along with all this goes the mental or psychologic preparation. The beauties and advantages of hospital life and treatment are extolled and instructions given as to how best to profit by them, how friendly everyone is to everyone else, etc. Incidentally the patient is put through a system of training in the matter of turning the eyes in various directions, opening and closing them without undue effort, and of having them touched and handled. Unless there is some positive indication, no local preparation is inaugurated prior to one hour, or even 30 minutes, before the operation. The use of antiseptics in the conjunctival sac and of bandages for a day or two before hand is omitted as worse than useless. Much of this subject is given in the Chapter on Extraction. Suffice it to state here that, by way of local preparation the eyelids and surrounding areas are scrubbed with sterile soap and warm water, followed by

rinsing with warm sublimate solution 1–2,000, the subject meanwhile keeping the eyes tightly shut. The supercilia are not shaved unless extra heavy. The cilia are washed, and the lids manipulated to empty the Meibomian and other ducts along the free borders. The cilia before extractions and iridectomies are coated by wiping them with cotton wet with benzin, and, lastly, the conjunctival sac is copiously douched with warm boric acid solution. A light boric acid dressing is then put on the eye and fixed by a simple muslin strip tied on diagonally, to be left till the time for the operation arrives. The hair of women is neatly combed back and braided. The nails are manicured and the hands are scrubbed. The patient is taken to the operating room in night clothing, i.e., all ready for bed. The eye is copiously flooded with warm boric or salt solution before, during, and after the operation. One attempts by this liberal use of a mild antiseptic to make up, as it were, for one's inability to employ a strong one.

Sterilization of all dressings, such as bandages, cotton, gauze, and of gowns, caps, masks, inhalers, etc., is done by means of the large steam autoclaves. Usually the various articles are done up in stout cotton bags, which are securely tied. They are not removed either from the sterilizer or from the bags until needed. All appliances, applications, implements, and drugs, of whatever description, used before, during, or after the operation, are sterilized by either dry or moist heat.

Everyone who has a duty to perform in connection with an operation is clad in a sterile gown and in a cap to cover the hair. Nurses and aids wear gloves, while the surgeon and his immediate assistant have mouths and beards covered by masks.

Surgeon's Operating Masks.—"The principal object of these convenient appliances is to protect the operative field against infection from the expiratory efforts of the operator and assistants in talking, coughing, sneezing, etc. They supersede the use, for the same purpose, of plain pieces of gauze tied over the lower part of the face around to the back of the head. By the latter method, however, aside from its being a far less convenient one than the other, to say nothing of the discomfort to the wearer, there was always more or less danger of having the operator's hands contaminated by coming in contact with the hair while in the act of

tying the gauze at the back of the head. This and other objections to wearing some sort of shield have been done away with by such wire masks as we illustrate; these may be easily attached to the head in a manner similar to spectacles, requiring only the handling of the mask itself, which should be previously sterilized. Wilson, of Bridgeport, has attachments on the mounting of his operating spectacles for holding the gauze mask.

"One of the two best-known patterns of these wire masks is that of Mikulicz, which consists of a wire framework so made that

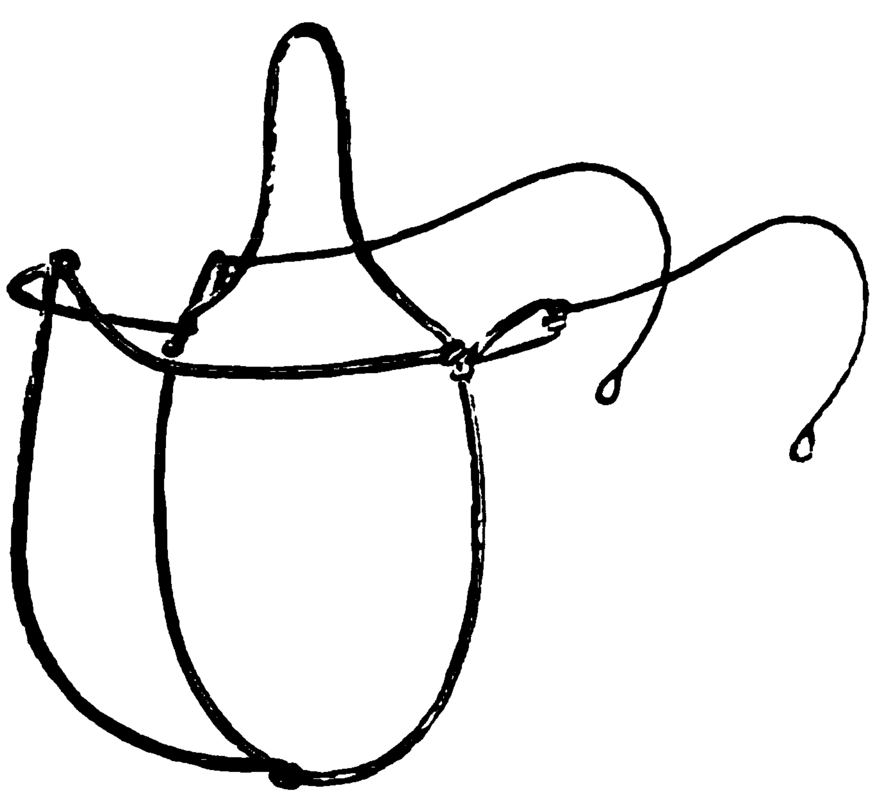


FIG. 1.—Mikulicz mask.

FIG. 2.—Mikulicz mask.

when covered with two thicknesses of gauze stitched to all sides, it effectually covers the nose and mouth of the wearer when it is placed in position. It is instantly adjusted to the head, and when not in use a number of them may be nested and temple bars folded over, so as to take up a minimum amount of room.

"The other pattern now being rapidly adopted by many leading surgeons and hospitals, as fulfilling the purpose admirably, is known as Tuttle's mask. This is a modification, by Dr. Edward C. Tuttle, of a somewhat similar contrivance used in some European hospitals; and while they are also made of wire, they are different in construction to those first described, as will be seen by comparing the illustrations shown herewith. On these frames the gauze is to be attached only to the upper part, but for the entire length of same, back to the very ends of the temple bars, so as to allow the gauze, after the mask has been put on, to hang down 16 to 18 inches

over the front and sides of the head, covering also the ears; the lower part of the gauze is then placed underneath the operating gown before the latter is buttoned up, afford'ng protection in every needed way. It will be seen that the bottom part of the frame stands out from the lower part of the wearer's face in such a position as to hold the gauze away from it, thereby insuring comfort.

"Of the two kinds of masks herein described, the first mentioned has the advantage of being instantly adjusted to the head, whereas the other, even though it may take a trifle longer to put on, is pre-

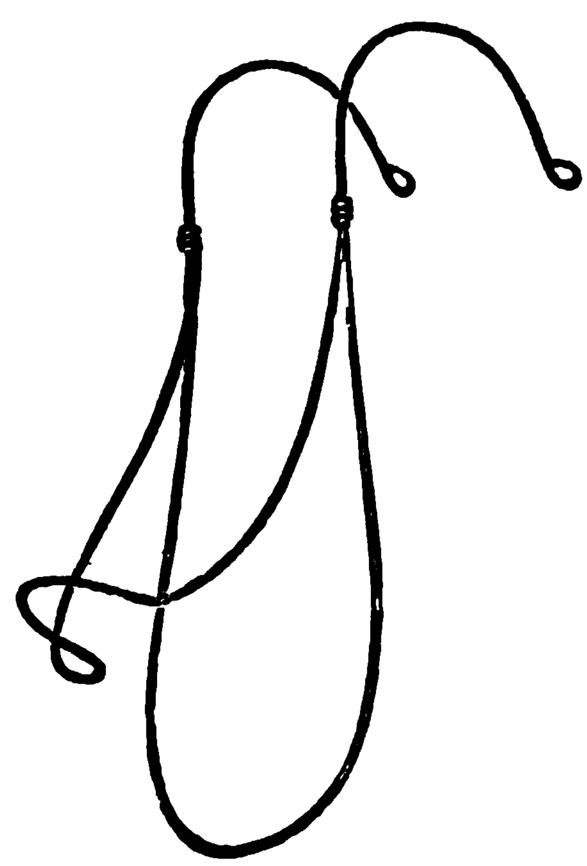


FIG. 3.—Tuttle's mask.

FIG. 4.—Tuttle's mask.

ferred by many on account of its giving the desired protection in a more complete way. It is well to note that where an operating cap is worn with a Tuttle's Mask, only the eyes and their immediate vicinity are left exposed, while the remaining portions of more than the entire front half of head and neck are completely covered. Furthermore, it should be remembered that both types mentioned are so constructed as not to allow the gauze to rest against the face of wearer, thereby enabling him to feel at perfect ease, which is not the case where gauze alone is worn; also that the wire temple bars may be easily bent, so that the masks can be readily adjusted to fit almost anyone."

The Operating Room.—The best sort of operating room, described in a general way, is one that is dry, commodious, that is well ventilated without opening windows or doors, easily heated in

winter, and that has an abundance of light. Particularly desirable is a broad north window. This insures a uniform light without interference by direct sunlight. If this window be set at an angle of 30° to 45°, inclining inward, it is preferable to a perpendicular window. Operations wherein corneal reflections can be a disturbing factor are made easier by a window thus inclined. With the patient lying on the table, feet toward the vertical window, as is the favorite position, unless the table be so far removed from the window as to greatly reduce the illumination, the image of the window lies inconveniently high up on the cornea. Now, if the window were tilted toward the table, just in proportion as the slant of the window would increase up to 45°, just in the same degree would the reflex be lowered. This is illustrated by the accompanying drawings.

FIG. 5.—*A*, Reflex near vertical window. *B*, Reflex near inclined window.

A and *B* represent the left eye of a subject lying on a table with feet toward the window. *A* shows the image of a vertical window and *B* that of one inclined inward about 40°, the distance of the table from the window being the same in both instances. Next in choice to the inclined window as a source of light is the vertical, though to get the best illumination the table would be placed diagonally, with the foot near the window. A sky-light is not satisfactory. Perhaps the best all-around light is the artificial, for by the use of portable electric phosphores, or other electric hand-lamps, and large biconvex lenses, one can get whatever intensity is desirable, and can cause the reflexes to fall wherever they are least in the way. Walls, ceiling, floor, woodwork and furniture of the room are all white and of materials, or covered with materials, that most readily admit of washing, fumigating,

or vigorous disinfection generally. Window shades are of a material easily cleaned, and work from below by heavy gilt (metallic) picture cord, so as to raise the least amount of dust in being put up or down. No pus cases and no re-dressings are allowed in the clean operating room.

Anesthesia.—Instead of the classification "local" and "general," it would be simpler and better English to distinguish these two conditions by the terms *anesthesia*, meaning the loss of sensation in any particular part of the body due to the contact of the sensory nerves supplying that part with a drug that causes temporary paralysis, and *narcosis*, meaning that condition of general stupor and unconsciousness, resembling sleep, caused by the wide diffusion of the poisonous drug in the circulation. Thanks to local anesthetics the eye-surgeon is now enabled to dispense with narcosis for the vast majority of operations. Indeed, there is no surgical measure resorted to by the oculist for which narcosis is not, now and then, omitted.

Local.—Local anesthesia is produced, in eye surgery, in several ways; as by the instillation of solutions of anesthetics into the conjunctival sac—applicable to operations upon the mucous membrane or upon the globe. Instillation of the same solutions into open surgical wounds—applicable to operations upon the globe or its appendages, and by the infiltration method of Oberst, or the combined infiltration and cocain method of Schleich; the last two being applicable only to operations upon the appendages. Another form of local anesthesia proper to mention is that by freezing with the spray of anesthyl or plain chlorid of ethyl or other highly volatile substance. This serves well for the incision of abscesses of the lids or orbit, especially in children or excessively sensitive adults. Of course, the eyeball must be protected from the cold. So far ophthalmic surgeons have had little or nothing to do with the intraneural method of Cushing, and nothing with the spinal anesthesia of Corning and Bier.

Of all the local anesthetics cocain, after twenty-five years of trial, still retains its supremacy. Its maximum of efficiency can be obtained with solutions varying in strength from 2 to 4%. Stronger solutions only serve to increase the objectionable qualities of the drug. Holocaïn stands next in popularity. It is effective

in solution of only 1%, and has the advantage of retaining its properties longer than cocain. The chief objections to cocain arise from overdosage or prolonged application. This leads to dryness and desquamation of the corneal epithelium, to dilation or relaxation of the blood-vessels, and to hypotonicity of the globe. The first favors infection, and the last two cause hemorrhage. The third objection is turned to a virtue, however, in glaucoma, where cocain, notwithstanding its mydriatic effect, may be used with impunity not only as an anesthetic, but also as a remedy. The first effects of cocain on the normal eye are contraction of the blood-vessels and perfect anesthesia. Hence, it is most expedient to operate during the primary stage in so far as it is possible. To this end the instillations should not be begun longer than ten minutes before the operation. A good rule is to start the boiling of the instruments and the application of the cocain simultaneously. Four drops with two-minute intervals is sufficient. If the eye be hyperemic it is less susceptible to the drug, but it can be blanched by adrenalin, and then anesthetized. A convenient and highly efficacious form of cocain application is the fresh sterile cocain ointment. This has such staying qualities that a single laying-on is enough. Moreover, it is said not to disturb the corneal epithelium when fat instead of water is the vehicle. Ramsay recommends a few drops of 5% chloretone solution, along with the cocain, to offset the harmful results to the epithelium. It has been often denied that there is aught accomplished by dropping cocain into the open wound in operations upon the appendages, but the facts do not seem to uphold the denial.

Infiltration Anesthesia.—It had long been known that a dense infiltration, of the skin, for instance, caused anesthesia of the part. Oberst, in 1889, turned this to account by producing artificial infiltration, by means of a hypodermic syringe and distilled or salt water preparatory to the making of incisions. Schleich, in 1889, went further, and added a modicum of cocain (1/8 to 1/4%) to the fluid for the syringe. Both these methods are rather extensively employed in the surgery of the lids. A wheal, or a series of wheals, of edema is raised at the site of the proposed operation by introducing a fine hypodermic needle nearly its whole length *into* the skin, and gradually withdrawing it as the liquid is injected.

To be free from danger, if the Schleich method is used, either the cocain should be in very minute quantity or else the ring of a clamp should be thrown around the wheal to prevent the solution from entering the general circulation. The anesthesia is absolute, but the changed aspect of the tissues, and the swelling, are against the procedure, as is also the greater post-operative reaction which ensues. A good formula for the solution is that of Guttman, of New York, to wit: Natr. chlorid 0.2, cocain hydrobrom. 0.05, aqua destill., 100.

Narcosis.—It would seem that there are always to be a certain number of operations, such as iridectomies for acute glaucoma, enucleations, extensive plastic measures, not to speak of those upon the timid and the very young, etc., that must be done under narcosis. How choose a narcotic? This is a matter that is largely a question of natural selection. That is to say, it is decided mainly by the conditions—the age and physical state of the patient, the character of the operation, etc. My preference would be for ether, preceded by nitrous oxid, all things being equal, but I would not give ether to persons of advanced age with diseased lungs or kidneys or to those with bronchitis. For these, provided the operation were of short duration, I would choose nitrous oxid followed by ethyl chlorid—or even the latter alone—or either alone. Chloroform is the nicest of all narcotics, but the dangers—one death in a little over three thousand—to my mind, more than counterbalance its advantages. Nitrous oxid is the safest, but it is impracticable for any but the briefest operations. Ether is practically as safe—one death in 15,000. The risks with ether are almost nil and those of chloroform are greatly lessened if they are given properly warmed, and after the most approved methods. A tyro ought never to be entrusted with the narcosis, and constant watchfulness is necessary on the part of the most skilled anesthetist. It is important that the psychic state of the subjects be favorable. To this end they are encouraged and cheered in every possible way. In addition to these suggestive measures those who seem to be filled with dread or fright are given a dose of some calming drug—1/6 to 1/4 gr. of morphin, 5 to 10 grains of chloretone, or 30 gr. of bromid of soda, 45 minutes to one hour before taking the anesthetic. The more composed the patient the more quiet the first stages of the narcosis,

and the freer the post-narcotic period from nausea. The practice of bringing the patient into the operating room in a perfectly conscious state, there to be confronted by surgeons and attendants, all gowned, and by a great array of paraphernalia suggestive of blood, completely demoralizes certain timid subjects and is much to be deprecated. The narcosis should be produced either in the private room or in a special anesthesia chamber. Above all, perhaps, is the importance of making the period of narcosis as brief as possible. In general surgery it is not so much the operation that counts for fatal results at it is deep and prolonged narcosis.

During any operation on the eye, the mucus which so frequently accumulates in the mouth and throat during the administration of ether, is most objectionable, as it necessitates stopping the operation for its removal and endangers the field. This excessive secretion may be most effectually prevented by the hypodermic exhibition of atropin sulphate gr. 1/200 to 1/150, combined with morphin sulphate gr. 1/16 to 1/8, about one hour before the operation.

Inhalers.—As to inhalers the simplest apparatus is usually the best. The drop method on a simple, gauze covered wire inhaler for ether and chloroform is about as good as any. I prefer Jordan's inhaler for eye operations as there is a notch for the nose at the top, and the handle projects over the chin, thus putting the hand that holds it out of the way. Where this is not at hand, the cone of towel and paper with absorbent cotton to hold the liquid, for ether, or a simple towel or napkin for chloroform, will answer the purpose. The subject is first made to breathe with the inhaler in place, but uncharged with the anesthetic. The latter is then gradually added. Screaming children may have a deep cone, i.e., with plenty of air space, saturated with ether clapped on at once, trusting partly to asphyxia to produce sleep. Along with the tanks of nitrous oxid there is always one of oxygen, and hypodermic syringes are provided, ready loaded with strychnia, brandy, or other stimulants, nor is there wanting the means for making infusion of salt solution. All these things to be used in an emergency *must be prepared and on the spot.* The patient is carefully watched for an hour or two immediately after the narcosis for the double purpose of noting his physical condition and of preventing injury to the eye or derangement of the dressing by some unconscious act.

Dressings.—The materials that compose modern eye-dressings are not of great variety or overnumerous, but their forms and modes of application, at the hands of the different individuals, are diverse as well as interesting. Relatively few seem to be so precise and exacting as a matter of such prime importance demands. If the surgeon himself is negligent and slovenly in this respect what can be expected of other attendants like internes and nurses?

Gauze.—This fabric does not enter so largely into the needs of the opthalmic surgeons as into the requirements of those who practise other branches of the art. It comes in sealed packages, supposedly ready for use, but it is well to sterilize it again if means are at hand for doing so. For the most part plain gauze—not impregnated with any drug—is employed. This should be of soft texture and highly absorbent. Borated gauze is interchangeable with the plain and stands sterilization perfectly. Certain of the impregnated gauzes, however, as the moist ones, lose their properties by the process and must be used directly from the can. Iodoform gauze is useful chiefly as a packing, e.g., in the form of tents for abscess cavities. Bichlorid gauze is apt to be irritating, especially to the skin of many patients.

Cotton.—The quality of absorbent cotton as found on sale is an uncertain thing unless one knows and can obtain particular brands. The best cotton is white, clean, of long fibre, and is instantly absorbent. It comes neatly laminated, and with the great bulk of the fibres running lengthwise of the bolt or roll. A distinctive feature is its *feel.* It is clingy to the touch, and when rubbed between the fingers show great friction. Poor cotton is not white, not clean, is shoddy, or of short fibre, is irregularly laminated, and, because of the oil remaining in it, does not readily absorb liquids. To the touch it has a silky feel, and when rubbed between the fingers is slippery. Absorbent cotton is used either plain or borated. It cannot be trusted without being freshly sterilized. The roll of cotton is not made into pieces of appropriate size by *cutting*, but by *pulling*. When cut, the edges are too thick and abrupt.

Bandages.—These are made of white flannel, gauze, muslin, or netting, cut into strips of suitable width and length. For a pressure bandage flannel is probably the most fitting fabric, because

of its elasticity This same quality makes it objectionable for general use; besides, it is rather warm for summer. Muslin, except it be of the sleaziest, is too stiff and unyielding. Gauze makes a fine bandage, but to be good it is expensive. The material that seems most nearly to fulfill all requirements is a good quality of white mosquito netting. This was first employed for eye bandages at the Illinois Eye and Ear Infirmary 22 years ago. Its use has now become almost universal in this country. The choicest kind is quite white, is well covered with sizing, has a moderately small mesh, is free from bars of heavier weaving, and costs, now, about 70 cents per bolt. The bolts each contain a single piece eight yards long and two yards wide. The length is just right for one double or for two single bandages. It is so folded that by opening the bolt very slightly one has a strip 1/2 yard by 2 yards, containing sixteen thicknesses. By pinning this to a cloth on a table, it can be cut with heavy shears—or pinned to a regular cutting table, can be more accurately divided with a strong, sharp knife. Thus, a cut of 18 inches will make a strip 8 yards long. The strips are exactly three and one-half inches wide They are nicely rolled, and the end fastened with a pin. The goods must be folded straight, and the cutting done with exactness, else the bandage will be on the bias and ravel badly. This bandage is applied wet—soaking wet. With a little practice it can be put on quite smoothly. It conforms to the head and, when dry, has staying qualities that are truly remarkable. The netting bandage is never used a second time. In order to remove it from the head it is cut with strong, blunt-pointed scissors just above the unoperated eye, or at the temple. Starch bandages are rarely used in eye practice. There are two forms of bandage, *the simple strip*, or tie (Fig. 6), and *the roller*, or full length. The last may be either double or single. For the adult bandage the width is three inches—strip or roller; for children, somewhat narrower. The netting bandage is made wider because, being applied wet, it stretches and grows narrower. The length of the simple tie is about one yard, or meter; that of the roller, four yards. The double eye bandage is, of course, 8 yards long.

Bandaging.—This is an art that few acquire to a high degree. Before applying the bandage a proper pad of cotton must be built

up over the closed lids. *Dry cotton must never come in contact with the bare lids, either in bandaging or wiping an eye*, as the loose fibres get into the palpebral fissure and irritate. This does not happen with wet cotton. A thin, gauze-like layer of cotton is lifted from a piece, it is fashioned into a rough square, measuring about two inches each way, dropped into a pan of boric acid solution, taken

Fig. 6. Netting strip. Also first step in application of collodion bandage.

up dripping wet and applied to the gently closed lids, with the fibres running vertically—i.e., athwart the palpebral fissure. Thus, each fibre helps to hold the lids together. This veil-like piece of cotton is smoothed down—squeegeed, as it were—on the skin, by gentle touches with the bulbs of the finger. On this is built, in a number of successive layers, a generous pad of dry cotton, being careful to fill in, first, the deeper depression around the globe. The

pad is not built straight out, i.e.—perpendicular to the plane of the front face—but inclined toward the temple, for the reason that the first turn of the bandage, coming as it does, from beneath the ear on that side, would, in the first instance, pull the pile of cotto over onto nose and forehead. It is highly imprudent and bungling to dab the whole quantity of dry cotton on in one big wad. The

FIG. 7 Collodionized netting bandage.

greatest pressure is thus brought to bear upon the cornea alone, instead of being evenly distributed over the lids and globe as when the pad is properly built on. If it is to be a tie bandage, the strip is laid, near its middle, onto the pad of cotton, and diagonally, one end passing beneath the ear on the same side, and the other up over the forehead on the opposite side, then the ends are brought together and snugly tied a little to one side of the top of the head.

If netting is used it is put on dry (see Fig. 6). If both eyes are to be bandaged, another strip is put on in the same way, or a single strip may be put straight around the head, and tying at the side—not over the occiput. Needless to state, tie bandages are not expected to remain on for long intervals.

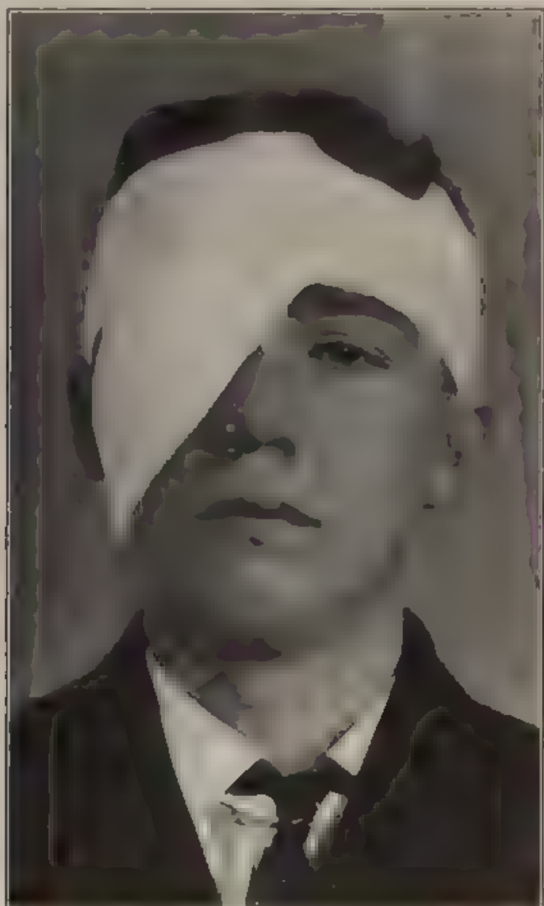


FIG. 8

Another of the Infirmary specialties in dressings is that shown in Fig. 7. It is, to begin with, the netting strip tied on as in Fig. 6, though extra smooth and tight. Now, it is painted over on forehead and cheek with a thick coating of flexible collodion.

As soon as the collodion dries, the bandage is untied and the ends cut off as shown in Fig. 7. This makes an excellent dressing, particularly for hot weather, or for children at any season, and for all ambulant cases. It serves well for women, also, who then have an opportunity of arranging their hair, which is always a source of worry to them when the entire head is swathed.

The Single or Monocular Roller. (Fig. 8.) The cotton pad is put on precisely as for the tie bandage described. The

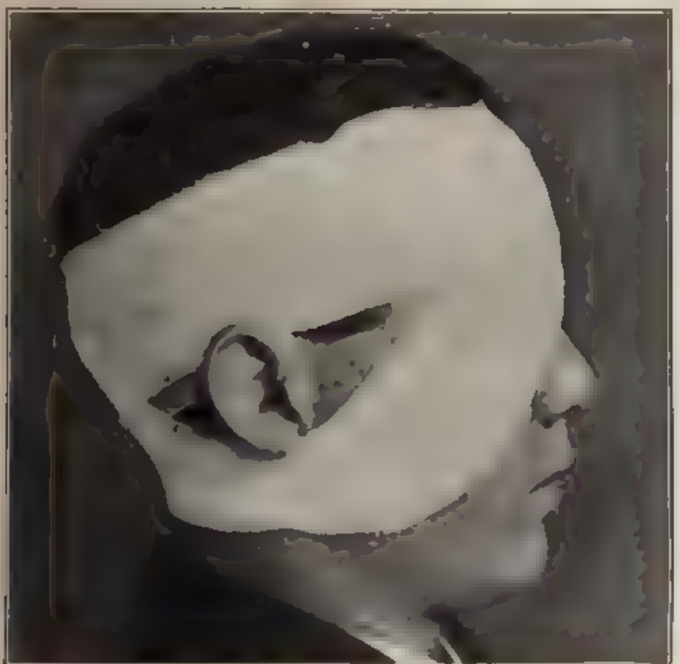


FIG. 9.—Profile view of monocular bandage to show manner of engaging occipital prominence.

four-yard netting bandage, well soaked in boric acid solution, is lightly squeezed to prevent dripping. The end is started on the forehead just above the eye to be bandaged and passing thence over the other eye. In the figure it is the right eye. The bandage is given one snug turn straight around the head and in such a way that the highest point of the occipital prominence is in the center of the strip. This prevents slipping either up or down (see

Fig. 9). The strip is carried on around, inclining downward at the left side of the head, but always keeping well above the left eye. It passes just above the left ear, then across the base of the occiput, then close up beneath the right ear, thence diagonally upward over the center of the pad of cotton, thence almost vertically across the forehead, as if it were going over the top of the head. Now it is reversed, carried downward and backward around again, passed again over the pad of cotton, this time with its edge against the nose—up and reversed as before, carried a third time around and up. This, the last turn that lies on the cotton pad, is carried more toward the right temple, so that now the entire pad is covered. It is again taken upward and reversed, but, instead of passing downward at the back, what remains of the bandage is passed straight around the head, as was the first turn. The end is fixed with two ordinary pins—not with safety pins. The edge of bandage, and frazzles of cotton at the side of the nose are tucked under with closed scissors blades. The bandage is not carried low enough at the back to rest upon the neck, for the movements of the head would stretch and loosen it. If, after the bandage dries, the patient complains of its cutting his ear, a drop of vaselin just at the spot will soften the netting there and give relief. It should not be nicked with knife or scissors.

The Double or Binocular Roller.—(Fig. 10.) The pad is put on each eye and a wad of cotton laid between them at the base of the nose. The bandage is started in the same manner as the single, but after the first turn around the head the strip is carried downward over the center of the pad covering the left eye (the right being the operated eye). It passes thence round the base of the occiput—under the right ear, upward over the right pad—again round the occipital prominence, again downward over the left pad, and so on. It will be seen that this is a regular figure-of-8 bandage. After three turns over each pad the remainder is carried straight around the head, to fix the whole, and pinned. Now, if a dab of flexible collodion be put on the thin places in the bandage here and there about the forehead and cheek the most restless patient cannot disturb it under 48 hours. This applies to the single or the double bandage or the tie. For extractions, and other particular cases, in addition to the dabs of collodion, it is my custom to paste on a

strip of gauze, half over the nose and half over the bandage, as in Fig. 11. This not only helps to secure the dressing, but, better still, prevents the patient from fingering the eye and from lifting the bandage. It must be borne in mind that the netting bandage loosens up a trifle upon drying, hence it must be a little tight when freshly applied. When the patient is lying on the table the head

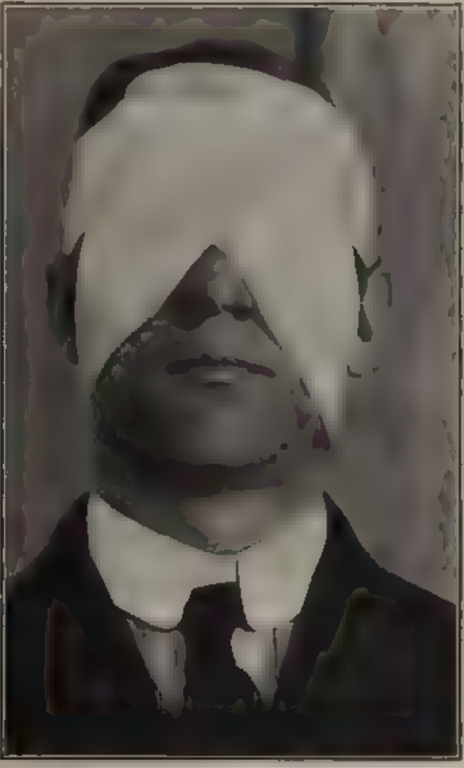


FIG. 10. Binocular bandage.

is held up free for the bandaging —*not by any effort of his own*— but by the hands of an aid. One hand is placed on the top of the head, fingers pointing backward, and the other beneath the chin. In this way the hands are not in the way of the bandaging.

Adhesive plaster as a means of holding eye dressings in place has been considerably used. In connection with gauze it does very well, but with cotton it makes a nasty mess.

Non-sticking Films.—Cotton and gauze have the unfortunate property of becoming firmly adherent to a bleeding wound, or a raw surface, when kept in contact for a few hours. This constitutes a decided objection, especially in dressings applied after plastic operations wherein mucous or cutaneous grafts are employed.

FIG 11

Despite the utmost pains in removing the dressing—long soaking, etc.—the graft may be loosened by traction of the adherent fibres, and perish in consequence. To prevent this, various substances have been placed next to the wound. Vaselin, for example, or a mixture of one part paraffin to 4 parts of vaselin may be smeared

onto the already moistened film of cotton. Better still is a layer of fine gutta percha tissue or the thinnest of gold-beater's skin, but the tissue or the skin must contain a series of small slits to

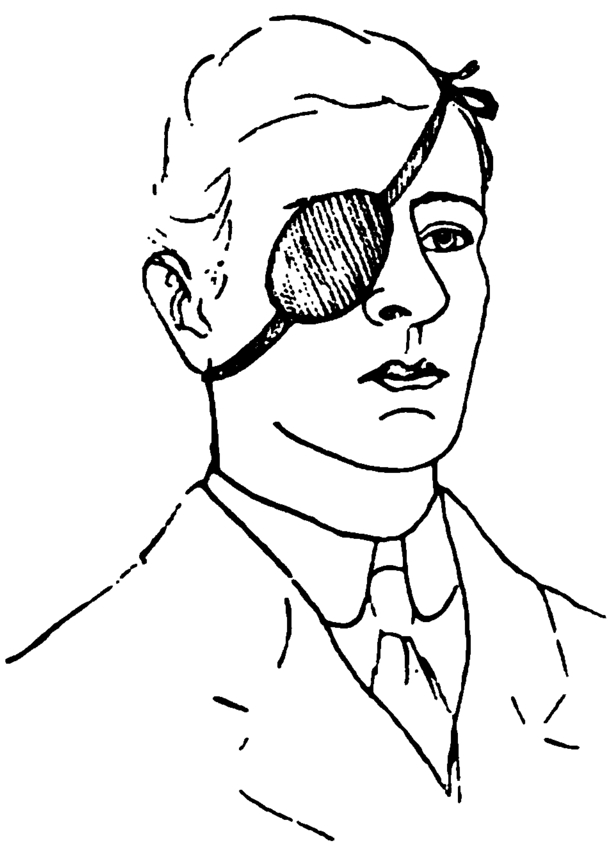


FIG. 12.—Monocular patch.

FIG. 13.—Binocular patch.

insure proper drainage. Pieces of these are kept ready in a jar of some appropriate antiseptic solution. If the solution is of a kind that is irritating to skin or flesh the film is washed with warm boric or salt solution just before applying.

FIG. 14.—Monocular patch.

Patches.—These are among the various devices for taking the place of the bandages. Like the bandages, they are made monocular or binocular, and of white or black cotton or silk. Figs. 12 and 13 show forms of single and double patch devised by Dr. Agnew, of New York, and first used at the Manhattan Eye and Ear Hospital. The single patch is of black sateen, two thicknesses, with stiffening between. It is oval in shape, the tape being attached in the long axis of the oval. The double one is black sateen outside, with white lining. Unlike the oval patch, it contains no stiffening. Both are furnished with black tape for

tying on, the last described having a piece fast to each of the four corners. It has a notch for the nose. The tape for all patches, shades, and shields should be left long on one side and short on the other, so that the knot will be at the side of the head rather than at the back. Fig. 14 represents a patch much employed at the Illinois Eye Infirmary. Beneath each is worn the regulation dressing, as

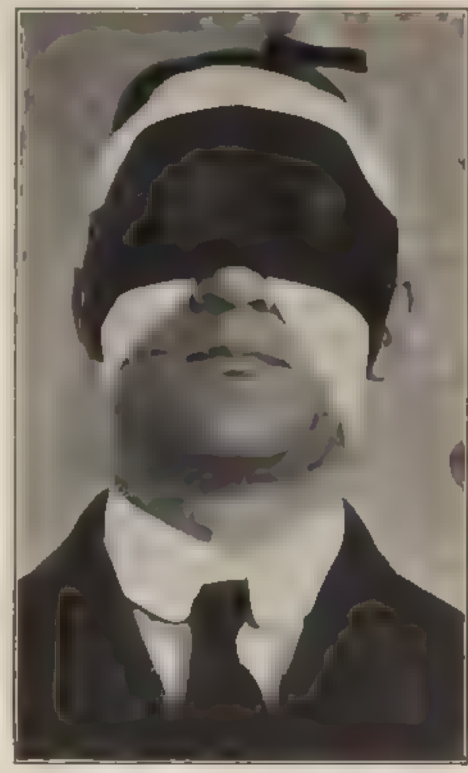


FIG. 15 Ring's mask over binocular bandage

described further back. Indeed, the object of all bandages and their substitutes is merely the holding of the dressing in place.

Protective Masks and Shields.—Many an operated eye, particularly after extraction, has been injured by a knock or a blow received on top of both bandage and dressing. It was to prevent such accidents that these were devised. One of the best is the mask given by the late Frank Ring, of New York, and shown

in Fig. 15. It is of sateen—black without and white within. It is treated with a heavy size in the making, then moulded into form, and can withstand considerable pressure without indenting. There are large concavities to receive the dressings, it fits nicely over the nose and is held on by four strings of black tape. Although it is made double, or binocular, it can easily be adapted to a single eye-dressing by merely cutting a good-sized hole on the side of the eye left open. Unfortunately, one will serve for a single case only, which is a slight drawback in a large charitable hospital, though not in private practice, as the mask is not expensive. I have long had in mind the idea of having made, after the Ring model, an aluminum mask, but with a circular opening ready-made at the cen-

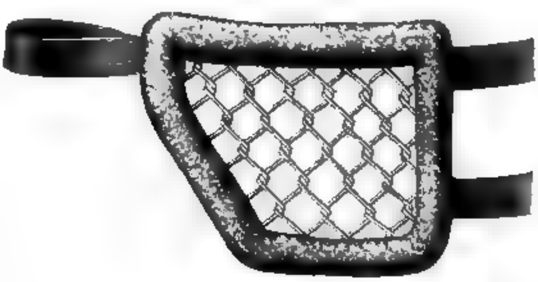


FIG. 16.

ter of each of the dressing concavities. Say these openings were one inch or an inch and a quarter in diameter, the mask would still afford ample protection from the usual sources of injury, and would be adapted to either monocular or binocular dressings. They could be manufactured economically by the stamping process, would be light, and could be cleansed and used over and over, indefinitely. Emerson, of New York, has also devised a practical protective mask. It is of wire, and in form is almost a counterpart of that of Ring. Fig. 16 shows the monocular wire mask of Fuchs. This is also made in binocular form. The last admit of vision in the unoperated eye if the dressing is left off. Figs. 17 and 18 represent rather cumbersome modifications of the Fuchs masks. Fig. 19 gives an idea of the metallic shield of Snellen. It is a shell-shaped contrivance with openings through which run the white tape by which it is kept in position.

Shades. After the eye has sufficiently recovered to leave off the dressing it is usually not in condition to be exposed at once to the full glare of light, to the air, and to the dust. Then it is that shades, goggles, and coquilles are put on. Shades also are monocular or binocular. Single shades are made of celluloid, flesh tinted, or, like the patch, of black silk, double, and with cardboard between

FIG. 17. Wire shield or mask, for one eye. Over monocular bandage.

the two layers. Double shades are most often made like the visor of a cap, and are of celluloid or *papier maché*. They are not worn to hold dressings in place and none should ever be placed beneath them. Any handy seamstress can make the single shades, the necessary materials being tough card board for stiffening, black silk or satin for covering, and black tape for tying on. They are usually made, a number at a time, by the nurses or other attendants

about hospitals, are sterilized, used for a single patient, for a few days, then destroyed. The tape is tied straight around the head, just above the eyebrows, and the shade hangs in front of the eye without touching even the lashes. Fig. 20.

Protective Glasses.—These are mounted either as spectacles or nose glasses—*pince nez*. They are either plain glass or lenses

FIG. 18. Double wire mask.

to suit the peculiar refraction of the wearer. In many instances the glasses are flat and of ordinary size, but they fulfill their office better if they are decidedly concavo-convex and of extra large lateral dimensions. These are called coquilles. They should never be of pressed or moulded glass, as they are then irregular concave lenses, which are very trying to the eyes, but should be *ground* into the proper form. Their protective qualities are due to their

color. Formerly, they were shades of green, then of blue, then of violet; later they were graded "smoke" or gray; and now orange or amber is *de régle*. Theoretically, they should be either deep amber or orange-scarlet or gray. In the first two instances they would act as ray-filters to eliminate the actinic and irritating portion of the light, viz., the violet and ultra violet. In the second, they

FIG. 19—Metal shield over monocular bandage.

would merely serve, according to the density of the gray, to reduce the intensity of the light. It is desirable in fitting coquilles to have them sit as close as possible to the eyes not to touch the lashes.

Goggles. The original of these were of plain glass—green or blue—surrounded by wire screens that rested snug against the lids, the whole being held in place by a rubber band around the head. Villainous things they were, too. Of recent years, especially since

the advent and rise of the automobile, there has been a veritable deluge of different improved styles, so that one were hard to please if he cannot be suited with a pair. Their glasses may be had in any tint, and some of them are about all that could be desired in the way of protective glasses.

Cleansing and Redressing.—All the beneficient results hoped for from a given surgical operation have often either not been realized or have been turned to actual disaster by inattention to some essential detail in the more immediate after-treatment. Many a prolapse of the iris after extraction, for example, has occurred through carelessness on the part of the one who removes the first dressing and applies the second. It is also safe to assert that similarly many an eye has been infected. The inconsistence of a large proportion of surgeons as regards their attitude toward the patient *at the time* of the operation and *after* the same is curious to behold. During the first few days not only is skill and care in handling needed, but trained supervision as well, to the end that the first signs of threatened complications may be detected in good season. When practicable, the patient is taken to a room especially prepared for the dressing—that is, *favorably* prepared—for a room used only for such purposes might be the least favorable. The air of the apartment must be as free as possible from dust. Great tact is resorted to in properly adjusting the patient's mental state to the occasion, for there is often more apprehension relative to "the first dressing" than to the operation itself. Persons of considerable intelligence are apt to have very vague notions as to what it means to have the eye "dressed," and a few words in explanation serve to relieve the situation as regards all concerned. Everything needed must be thought of and *at hand*. Towels are put around the patient's neck and around the head to cover the hair, and a catch-basin is placed beneath the chin. In most instances it pleases the patient

FIG. 20.—Monocular shade.

to be allowed to hold the basin, as he feels that he is helping the cause. He is cautioned to keep *both* eyes gently closed, and not make any effort to open them until told to do so, and that he must never squeeze them. The bandage is cut, and is so stripped off as to leave the pad of cotton covering the eye. This is usually stuck more or less tightly to the lids, so as to require soaking slightly by dropping warm boric acid solution behind it with a dropper to make it let go. After cutting and removing the bandage, and placing the towel over the hair, it were best that the dresser put on a pair of sterilized rubber gloves. I know this is seldom done, but it is the proper thing. The warm solution for use with the cotton sponges is in a glass flask or in an ordinary eight-ounce bottle. From this it is poured upon the sponges, over the catch-basin. It does not comport with true cleanliness to dip the sponges into a vessel of liquid with the fingers, especially if they be not gloved. Always warn the dresser as to what is about to be done. The mere touching of a finger to the forehead or of a sponge to the lids might otherwise cause a tremendous start and a squeeze. He is also told not to put up the hands. What follows here refers mainly to cases where the operation has been upon the globe. The first sponge is made dripping wet. It is oblong, and one end is allowed to project well beyond the tips of the fingers to avoid giving the eye an unguarded poke or thump. This loose end is raked gently back and forth over the eyelashes to soften the dried discharges from the eye accumulated along the palpebral fissure. Following this, another sponge, but wrung dry this time, is lightly drawn along to drink up the moisture clinging to the lashes. After the first sponge, all of them, while wet, must yet be in a more or less absorbent condition—that is, they should *take* from the parts they touch rather than *give*. Observance of this point prevents driving polluted solution from without into the eye. Several wet sponges are used about the lids, brow, nose, cheek, and temple, always beginning at the center of the area to be washed and ending at the periphery, i.e., never going back to the lids or to the cilia with a bit of cotton that has touched the adjacent surfaces. A sponge is never re-wetted and again applied. By way of a finish, a pledget is squeezed hard, and with it the parts are sponged to free from drops. The lids of the unbandaged eye are also often glued

together, so that it, too, should be bathed, then opened, by the dresser—not by the dressee. With oblong sponge in the fingers of one hand one proceeds, with the thumb of the other placed over the upper rim of the orbit, gingerly to lift the lid of the operated eye. If it is still stuck the wet sponge is again brought into requisition; meantime repeating the command that the patient make no attempt to move the lids himself. When it is seen that both eyes are free to open he may be asked in a quiet manner to open the eyes and to look in any desired direction, and to avoid snapping and nipping of the lids. Having been assured that the patient has proper control of the lids, one may proceed more thoroughly to cleanse lashes, free borders and canthi; using the long end of sponge. Cleansing and inspection are made to consume the shortest time consistent with prudence, not to expose the eye unnecessarily to harmful agents. Whatever is indicated in the way of medication or other attention is now disposed of and the eye re-dressed as per instructions given under "Bandaging." Each time, as one is about to make the application, irrigation, instillation, or the like, it is made known to the patient what to expect. It is neither safe nor pleasant, as regards the party most directly interested, to have things put into and upon the eyes without any sort of warning, even when deftly and gently done. How much worse, then, to have them dropped from heights, squirted forcibly, and shot in, or dabbed on with a splash!

The Removal of Sutures.—It is a curious fact that there is almost as much dread of this performance on the part of our patients as of the operation that makes it necessary. Sometimes there is even more. This is something they have not counted upon and nerved up for, and it is faced with a poorer grace in consequence. Hence, great adroitness is often required to bring them to the point of calm submission. They must be disabused of the idea that the thread is tightly adherent to the flesh and that the instruments are put in actual contact with the parts involved. On the other hand, it is well to have impressed upon them the dangers of leaving the sutures *in situ* after the lapse of a certain period. Indeed, this is not a sophism got up merely to influence the mind. Sutures should be got rid of just as soon as they have served their purpose, and this is much earlier than many seem to suppose. After that they

not only continue to act as foreign bodies but, worse yet, they' together with their canals, form most alluring open roads for the entrance and growth of bacteria. Ordinary cutaneous and conjunctival sutures ought not to remain longer than 48 hours. A few special ones, such as advancement and ptosis sutures, would better be left longer—from 4 to 8 days. If the sutures are outside of the conjunctival sac they are first softened and cleansed with a moderately strong, warm, antiseptic solution, and wiped fairly dry. The most suitable instruments for the purpose, to my mind, are a pair of small, but stiff, dressing-forceps and a pair of small, blunt-pointed scissors, curved on the flat—Stevens' strabismus scissors, for example. Toothed forceps do not seize the thread readily. It is indispensable that the scissors cut well at the very extremity of the blades. It is best to have the patient prone upon the table, though he may sit upright. In either case the head would better be steadied by an assistant. The same helper may also hold the lids apart when the sutures are inside the palpebral fissure. But, in the latter case, unless one is pretty sure of his patient, and his assistant, it were better to use a blepharostat at once, the eye having, of course, been cocainized. The operator steadies the hands on some contiguous part, and watches closely the tendency of the operated, so as to be in the closest touch in order to anticipate moves or to move with him, thus avoiding sudden yanks upon the thread. In taking out cutaneous sutures an end of thread is grasped with the forceps and so pulled upon as to draw the suture well out of its canal on that side; it is then cut close up, the scissors being held with the convexity of the blades upward. In this manner one obviates pulling a soiled portion of thread—a part that has lain on the outside of the skin—through the entire stitch canal, to possibly infect it. A wet cotton sponge is held, or laid, conveniently near, on which to wipe forceps or scissors. There is usually slight bleeding which may require sponging. The stitches all removed, the parts are again bathed with the antiseptic and sponged.

Sponges.—The natural sponge, as a part of the surgeon's armentarium, is a thing of the past, having been, quite properly, superseded by the artificial kinds. They are made chiefly of cotton or gauze—preferably the former. Indeed, gauze sponges are

seldom used in eye surgery. The regulation shape is fusiform, and the sponges vary in size according to the nature of the operation with which they are to be used. Those destined for the surgery of the conjunctiva and the globe are the smallest, measuring, when freshly wrung, about two inches from tip to tip, and one-half inch across at the middle. For operations upon the lacrimal apparatus, for enucleations and the grosser plastic operations they are larger, and less fusiform. The property most essential in a sponge is great absorptivity. It is not alone sufficient that the cotton from which it is made is highly absorbent, the sponge must be compressed and damp. Dry cotton, no matter how fitting the quality, lacks this property; and so does damp cotton if in a loose wad. Besides, dry cotton is most objectionable in surgery because of the detached fibres getting into the wound and clinging to the instruments. To the most effective the sponge must be *newly* and *tightly* wrung out of the solution with which it is impregnated. It is a mistake, therefore, to make and wring, then sterilize them in the autoclave, and consider them ready for use. They are made too dry and too loose in this way. They should be freshly prepared from sterilized cotton. The hands of the one who makes them are clad in aseptic rubber gloves. Pieces of suitable size are pulled from the roll of cotton and fashioned into shape by the fingers and by rolling with the palms. They are then dropped into the antiseptic solution, covered securely, and left there till needed, when they are wrung again with the gloved hands, a few at a time and put on or in some sort of server. It should be remembered that the tips are the working parts, hence, they should be handled at their middles by both the surgeon and the aid who passes or uses them. By the operating table is an enameled jar with inverted cone for cover, and truncated by an opening. Into this the discarded sponges are dropped, and not scattered promiscuously all around. Nurses and assistants need considerable training in the matter of sponging before venturing to help in this capacity at an operation. It is no mean art. They must know when to take the initiative, and when to wait for an order to apply; when to hold out the sponge for the operator to wipe an instrument upon, etc. The corneal epithelium is to be spared contact with the sponge whenever practicable.

Applicators, Brushes and Swabs.—An applicator may be of metal or wood. It serves merely at the handle for a brush or a swab. Of the metals silver is probably the best adapted to the purpose. Excellent wood applicators are found ready made in tooth picks, especially those made of bamboo, called Japanese. The great advantage of these is their extreme cheapness, admitting of throwing away after once using. Whatever the material, the eye applicator must be delicate and light. One and one-half to two mm. thick at the large end, thence gradually tapering to a point, or nearly, and ten to twelve centimeters in length. Not infrequently metal applicators are seen that are roughened, or nicked, for a short distance from their working ends. This will do in a

FIG. 21. *a*. To make a brush. *b*. To make a swab.

wooden one, that is not used a second time, but is a serious drawback in a metal one, for reasons given further along. The same objections may be urged to the probe, or bulbous pointed applicator. Formerly, camels' hair brushes were used in the treatment of eyes. In the light of modern medical science they would be deemed abominations, and justly so. The ideal brush, or swab, is now made of absorbent cotton wound onto an applicator. It all lies in the manner of the winding whether the brush or a swab is the result. The difference between the two is just what the names imply—the brush having a pliant free end and the swab being a compact bunch. To make a brush a small quantity of cotton is taken from the rool and its irregularities of outline are pulled off till it assumes the square shape shown in Fig. 21. It is so held between the left thumb and index that the fibres composing it run horizontally. The small end of the applicator is laid diagonally across the upper right

hand corner (Fig. 21 *a*), and the shaft of the applicator is revolved with the other thumb and index *away* from the maker, at the same time the right thumb and finger help the instrument to get hold of the extreme corner fibres of the cotton. As soon as these begin to wind on, the left thumb and index take a firmer hold on the cotton, to make the winding *tight*. All that remains is to continue turning the applicator till all the cotton is wound on, and the brush is made. If it seems too long or uneven, the fibres are pulled out till it assumes the proper dimensions. To make a swab or firm mop, one takes the same thin, square bit of cotton, but before starting to turn the applicator, which is laid on just as for the brush, the fibres are made to run in the *vertical* sense (Fig. 21 *b*). The winding is begun as before, but when it has got well under way, the fibres that would otherwise project beyond the end of the shaft, are turned backward by the left index, and the turning kept up until all the cotton is on and smoothed down into a good, firm, rounded mass. In both instances the cotton is wound on very tightly. In this way the implement will bear sterilization. No roughening is needed to keep the cotton from slipping off. If made properly, the cotton will only come off by unscrewing it, as it were, i.e., turning the shaft in the opposite sense, or *toward* one. In this way it may be stripped off at once, whereas if the shaft is roughened the cotton *will not strip*. The brush is employed when the remedy is to be painted or penciled on, the swab when it is to be rubbed on. The swab is also useful in putting ointment into the eye, as well as for rubbing it on.

Droppers.—By the term eye-dropper is commonly understood the combination of small rubber bulb and glass tube with narrowed extremity. The word *pipette* is sometimes used as interchangeable. The last is literally "little pipe," and refers to the old medicine dropper, or drop-counter, which consists of a glass tube without the rubber bulb. The small end of the tube is immersed in the liquid and when enough has flowed in, the finger is clapped onto the larger end. The tube may then be lifted out and no liquid will escape till the finger is raised. Both appliances are useful in ophthalmic practice. The pipette is only adapted to the gentle instillation of one or several drops, while the eye-dropper may, in addition, be used for a forceful and copious flushing. This is true,

at least, of those with the larger bulbs, for glass and rubber can both be filled. Those with tiny bulbs are specially designed to make it impossible to fill them full—an admirable thing in an unsterilized dropper, as the rubber cavity contains a powder that contaminates. Whether the narrowed extremity is curved or straight makes little difference, though the straight one is more easily cleaned, and will enter more readily into the mouths of vials. The smaller the opening in the end and the sharper the end itself, the smaller the drop that is formed, and small drops are sometimes preferable to large ones. The pipette is free from some of the annoyances caused by the rubber, is easily sterilized, and is sure to work and not to leak. Who has not seen the dropper, in careless hands, made to suck back, by relaxing the hold on the rubber bulb while the tip is in fluid, like blood, or pus? In truth, allowing the tip of either dropper or pipette to actually touch the parts is inexcusable. Much vexation—even calamity—has been caused by getting droppers mixed, putting borric acid solution, for example, into a glaucomatous eye with a dropper that has been used for atropin solution. To obviate this, the bulbs may have marked on them, with indelible ink, the name of its particular drug; or the rubber may be of different color for each of the more mischief-making solutions.

The method of instilling drops with either the eye-dropper or the pipette deserves a word. A few drops are drawn into the glass tube, the forefinger of the free hand is placed just beneath the lower lid, which is lightly depressed, to open the lower cul-de-sac, the patient is told to look upward, the dropper is approached till its tip is about one-eighth of an inch above the center of the free border, when a drop is squeezed out and allowed to touch at that point. It immediately enters the conjunctival sac—attracted by the moisture on the inner side of the lid (Fig. 22). If the patient cannot control the lids, the middle finger holds up the upper lid while the index depresses the lower. In cases of children and excessively touchy persons, it is made easier by putting them flat on their backs. The drops should never fall from a height, but should either be made to touch the free border, or be let fall a few millimeters only into the inner canthus. If the cul-de-sac is full of tears, the drop will simply cause an overflow and be wasted.

A sponge is first used to exhaust the tears. The systematic effects of poisonous instillations can be, in great measure, prevented by having the patient compress the canaliculi with the forefinger.

Fig. 22.

It need hardly be urged that the finger must be there before the drop is put in, else the first winking of the lids will draw the solution into the lacrimal sac. This precaution is especially advisable when the instillations are repeated in quick succession.

Irrigators or Douches.—These refer to various appliances by which quantities of liquid are brought into contact with the eye for therapeutic purposes. They work by (1) ***pouring***, as from special vessels, the stream being directed by a spout and controlled by placing the finger as a valve over a separate opening; or by (2) ***gravity***, as from elevated reservoirs, when the stream is directed by a rubber tube and controlled by compressing the tube; or by (3) ***ejection***, as from some form of syringe, in which the stream is directed as in either of the foregoing, but is controlled by pressure upon a rubber bulb. To the first belong the divers glass and enameled flasks known as *undines*, *compte-gouttes*, etc. (Fig. 23); to the second, the

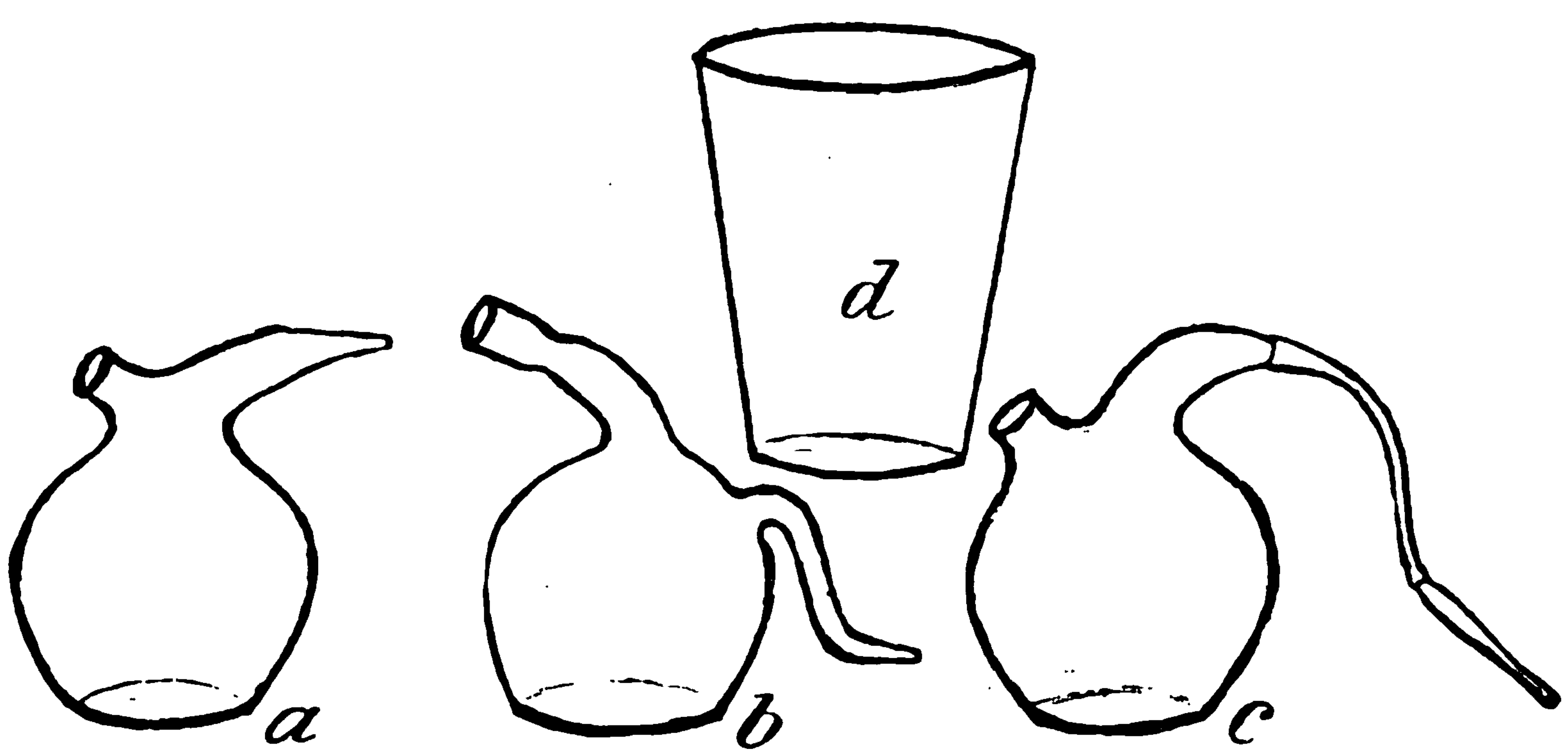


FIG. 23.—*a*, Undine. *b*, Morax *compte-gouttes*. *c*, Wickerkiwicz eye douche. *d*, Tumbler to show relative size.

fountain syringes, the percolators, and the tube syphons; to the third, the bulb syringes, bulb-syphons, and hand-sprays. The eye-dropper is but a form of bulb-syringe. The glass flasks are most appropriate for gentle washing of the eye. They are neat and cleanly, and the stream is gentle except they be held too high. They are necessarily of limited capacity in order to be convenient to hold with one hand, therefore adapted to the less copious and prolonged irrigations. Those in the second category are just the ones designed for irrigation on the larger scale. The reservoir is of soft rubber, enameled metal, or glass, and may be of any desired size. Some of them are quite elaborate, having means for heating, thermometer attachment, etc. Reservoirs of glass, however, will always appeal more

strongly to the aseptic instinct, because of their transparency, and their resistance to all modes of sterilization. The force of the stream is governed by the height to which the source is elevated, and, to a limited degree, by compressing the tube with the fingers. There are different devices by which the liquid is delivered to the eye after passing through the rubber pipe. The simplest is a nozzle composed of the glass tube of an eye-dropper. Then there are the multiple vent-nozzles, some form of which is very desirable in irrigation of the upper cul-de-sac, particularly in purulent conjunctivitis. Among the simplest is one of glass, celluloid or hard rubber, of flattened, rounded shape, after the manner of Jaeger's lid spatula, with several openings in the free, or specialized, end. An effective, though rather complex attachment is the irrigating retractor of Lagrange (Plate VIII, No. 93). As to the ejectors, their name is legion, and they are, on the whole, least to be recommended, as they are, for the most part, complex, unreliable, and bunglesome. The one uncompounded style of this class is the rubber bulb alone, or the bulb with glass spout, as represented by the common eye-dropper. Their streams are steady, intermittent, or broken into spray. Among the last, one of the least objectionable as well as of the earliest, was suggested by Agnew, of New York, and is known as the Manhattan Eye-douche (Fig. 24). Its extreme compactness enables one to manage it easily with one hand.

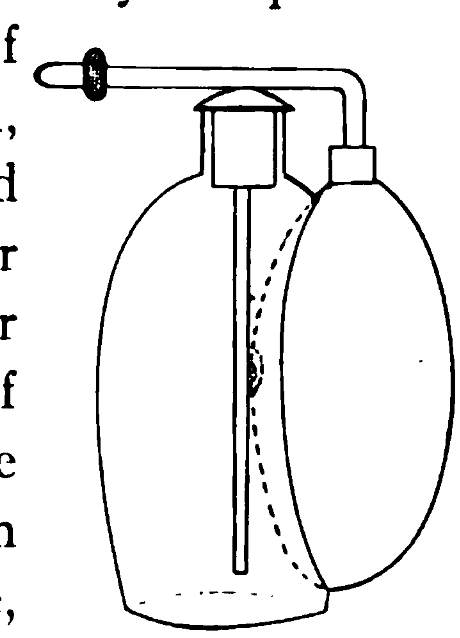


FIG. 24.

Eye Cup or Bath.—This is the primitive douche. It is a small cup whose lip is designed to fit snugly just within the bony rim of the orbit. It is filled and put into position with the head thrown far forward—prone. The head is then inclined in the opposite direction, or supine, and while the cup is held close, the eye is alternately opened and shut. This serves to bathe the cornea and part of the ocular conjunctiva, but, as the lids fit almost water-tight to the globe, the liquid does not reach the fornices to any great extent.

Irrigation or Douching.—*All solutions must be freshly made and of the purest ingredients it is possible to obtain.* As a rule, the

liquid for the procedure is warm, 100° or more. It is thus more agreeable and more efficacious. The patient may sit or lie. Towels are placed round neck and over hair. A catch-basin is held—usually by the patient—to catch the overflow. If the posture is sitting, the basin is held as in Fig. 25, except that it is put more toward the side upon which is the eye that is being treated. The concavity of the basin is held tight to the neck, and it must be seen to that no part of the towel gets in between neck and basin, so as

FIG. 25.—Manner of holding catch-basin. Sitting.

to overhang, or project above the rim, for this would form a drain that would lead the liquid down the neck. If the posture is lying, the basin is held close beneath the ear and angle of the jaw, as in Fig. 26. Same precautions. The lids are washed and sponged with absorbent cotton. The lids are everted, one at a time or both at once, and the warm solution poured gently on them. The lids are replaced, the upper one is raised by placing the thumb over the upper rim of the orbit, the patient is made to look down, and the stream is played over the cornea and conjunctiva. The gaze is then ordered upward, the lower lid is depressed by the index,

and the lower fornix is irrigated. All the while, the vent of the irrigator, whatever the kind, is held close up, so as not to shock the eye. The cornea, in particular, soon becomes intolerant of the douching unless the force and the temperature of the stream are just right. A very strong jet is justifiable only for the dislodgment of a sticky discharge. Under proper conditions, no unfavorable reaction follows prolonged and copious irrigation.

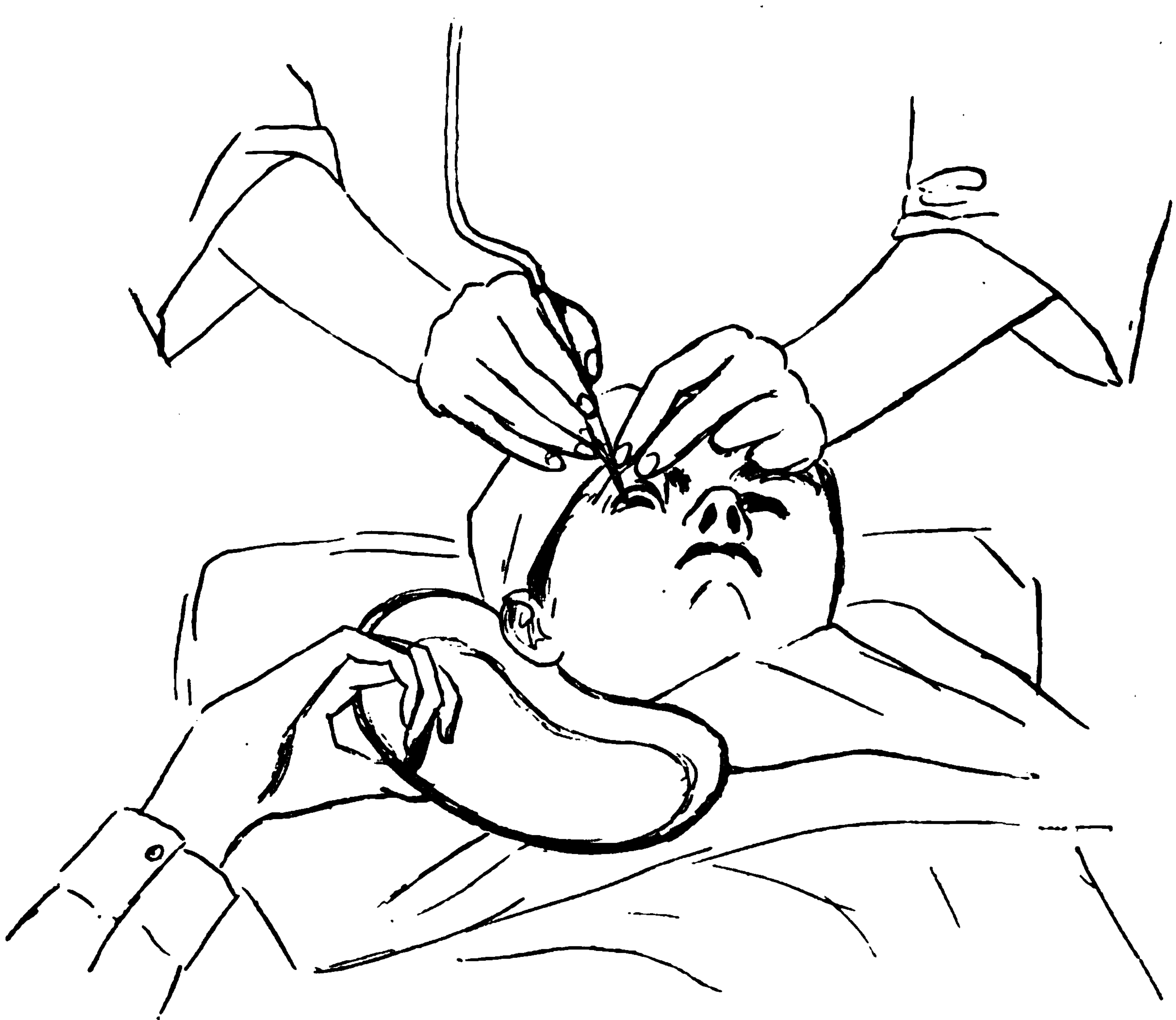


FIG. 26.—Manner of holding pus-basin. Recumbent.

Ointments.—The fatty media of ointments suitable for use in the eye are chiefly vaselin, lard, castor and olive oil, and lanolin, or a mixture of these substances with varying proportions of beeswax or paraffin, to give greater firmness. As this is not a chapter on ocular therapeutics, but one on the technic of applications, the aim here is to indicate the manner of handling and putting the ointment into the eye. The most convenient, preservative, and sanitary receptacle for the ointment is the collapsible tube of block tin. A very few have ingredients that are not compatible with

the tin. Next to this is the light-proof glass, or porcelain box, with screw-cap and paraffined washer. The tube, or box, should be small—holding two dr. to 1/2 oz. Large quantities are not admissible, as the ointment should be quickly renewed. The ointment is applied by means of the cotton swab wound on an applicator, as described a little further back, or of a naked, smoothly rounded silver probe. If the swab is used, it is first moistened with boric acid solution. This keeps the cotton from taking up too much of the ointment and also causes it to let go easier. The

FIG. 27.—Method of applying ointment.

requisite quantity—say, a mass the size of a split pea—is lifted from the box, or squeezed from the tube, as nearly as possible on ***the very extremity of the instrument.*** The lower lid of the patient is depressed with the left index, while, with the middle finger, the upper lid is supported. The patient is told to look upward, the ointment is approached to the eye with the probe held in a horizontal position, and parallel with the palpebral fissure, the handle pointing outward; the end holding the ointment is laid gently in the lower cul-de-sac, the patient's lids are then closed, and the probe withdrawn toward the temple, leaving the ointment behind (see Fig. 27).

Caustics.—The peculiar chemical energy of these substances, when brought in contact with living tissues, makes them at once either most serviceable or most pernicious—all depends upon the conditions and manner of contact. Among the more common caustics used in ophthalmic practice are alum, sulphate of copper, nitrate of silver and carbolic and chromic acids. They are employed pure or in mitigated substance, or in aqueous solution Mitigation and solution both mean simply dilution to lessen the severity of the agent. The first is accomplished by mixing with the caustic an inert powder, usually nitrate of potash or borate of soda; the second by the strength or percentage of the solution. The pure, the mixed, and the mitigated substances are all to be had at the pharmacists in sticks, or crayons, ready pointed, fast in holders and with cap to cover. If the crayon needs sharpening this is best done by rubbing it on fine sand-paper, care being taken to keep down the dust; that is, the rubbing should not be done in a draught, and the sand-paper should not be flirted about. Whether applied pure, mitigated or dissolved, the touch to any part of the eye, particularly of the more active caustics, should be by a fine point. For the solutions, the cotton brush on the applicator is used. The eye is bathed and sponged, the part to be touched is *wiped dry* with a bit of gauze, then the caustic is applied. As the object is to affect only the diseased area the caustic must be scrupulously kept from spreading to the healthy tissues. If done with the crayon, there will be little tendency to spread so long as no moisture comes in contact with the spot treated. Hence, in touching any part within the palpebral fissure, it is necessary to keep the tears all away by means of the little, spindle-shaped cotton sponge. In order to strictly localize the application when in solution and with the brush, it is essential that there be no superfluous fluid in the brush. That is, there should not be so much that when the contact is made a drop will be given off, to run down over the healthy surfaces and injure them. The tip of the brush is first touched to a sponge. Here, too, the tears must be kept away, just as in using the crayon. The application having been deemed sufficient, if within the conjunctival sac, the action of the caustic is always nullified at once by plentiful douching either with warm solution of boric acid or of something that will neutralize chemically,

as, of common salt, for example, when the caustic is nitrate of silver. It contributes much to the comfort of the patient if a drop of cocain solution is put in just before the application, and another just after the douching.

FIG. 28.—Thermaphore

Heat is most grateful and beneficial to the eye in most all of its inflammations and painful affections. It may be applied either *dry* or *moist*. A primitive mode of using dry heat is to heat some salt in a skillet, tie it up in a woolen stocking and lay on the eye. A more up to date method is by means of hot water in a rubber

bag, but the first will still answer in a pinch. Yet other simple modes are to heat small pads of cotton or wool in an oven or Japanese muff-warmer or, best of all, beneath a hot flat-iron. Among the more scientific methods is that by the *thermaphore,* illustrated in Fig. 28, and that by the *electric pad.* The thermophore consists of a double tank for the water. The hot water flows outward from one tank through a rubber pipe, passes through a rubber coil (A), thence returns through another tube to the other tank. The heat is supplied by a gas-burner or a spirit lamp. The one shown in the illustration has four sets of pipes and four coils, suitable for both eyes of two persons, or one eye each of four. The coil is wrapped in a small towel before applying. In lieu of the elaborate heating apparatus one may use a jug of hot water, placed somewhat higher than the patient's head. From this the water is syphoned through tube and coil, and thence to another jug on the floor. The supply jug is wrapped in woolen cloth to retain the heat. *The electric pad* consists of a resistance coil contained in an asbestos envelope, and connected by insulated conducting wires with the socket of an ordinary incandescent lamp. The heater is wrapped in dry flannel before using. The temperature of either pad or coil must be carefully watched to avoid burning the skin. If the source of heat is not continuous the application is renewed every few minutes. The duration of either procedure is from 5 to 30 minutes. The temperature is usually as high as can be endured or just short of doing harm. *Moist heat* may be either plain or antiseptic. The simplest form of either is that of bathing or douching. To bathe the eye with a hot liquid the patient would better sit erect, so that there is a minimum of blood in the head. Stooping over would cause congestion. The water or solution is contained in a bowl or basin, held close up beneath the chin, and is dabbed on, over the closed lids, by cotton, gauze, or a piece of clean soft linen. The conjunctival douche is applied as already directed. Or the applications may be in the form of fomentations—plain or antiseptic, such as small pads of cotton or wool, wrung out of the very hot liquid, or out of moderately hot, and further heated under a flat-iron. This obviates burning the hands of the attendant. As soon as the pad is in place it is covered with a dry flannel cloth or other non-conducting material. Of course, the

heat from the rubber or the electric coil may be made moist, plain or antiseptic, by keeping the wrapping of the coil wet with the appropriate liquid.

Cold finds its chief indication in severe, acute inflammations of the conjunctiva, and immediately following injuries of the eye or its appendages. Like heat, it is applied *dry* or *moist*. Dry cold is most often from cracked ice, in a rubber bag, laid on the closed lids. A good plan is to syphon ice water through a very small rubber tube from a large vessel, placed just a little higher

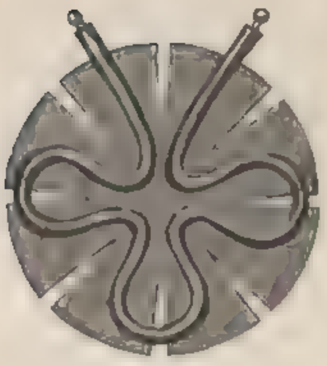


FIG. 29.

FIG. 30.

Leiter's coils of soft rubber tubing for dry or moist heat or cold.

than the patient's head through a coil laid on the eye, thence, through a still smaller tube to another vessel (Figs. 29 and 30). This has been called *mediate irrigation*, and may be either dry or moist. Leiter's lead coils are too heavy for use upon the eye. Moist cold is best transferred to the eye by bits of old, heavy table linen. This is more absorbent than new linen. One need hardly say the linen must be aseptic. Pads two to two and one-half inches square, and composed of several thicknesses, are wrung out of ice-water and laid on the lids. A more convenient way is to put a large block of ice into a pan or basin and lay six or eight of the linen

pads onto the block. They are patted down into good contact, and, when one is wet through, it is placed smoothly over the eye. Every minute thereafter the used pad is put back on the ice and a fresh one put on the eye. The patient is apt to take a sort of grim pleasure in making the applications himself and can be, with impunity, intrusted with the task. Indeed, this is true of most of the applications of heat and cold.

The author has found the following a most convenient and highly effective manner of applying moist heat or cold: The patient may be either seated or recumbent. A catch-basin is so held as to fit snugly to the neck on the side of the affected eye. A moderately large pad of absorbent cotton is dipped into the liquid—hot or cold—that is to be applied, then laid, without squeezing, on the closed lids. The attendant then drops the liquid from an ordinary eye-dropper continuously over the pad of cotton. The cotton remains soft and in perfect contact with the skin, the temperature is evenly maintained, the eye is not shocked by too sudden sense of heat or cold, the patient is not disturbed by any changing of the application, nor of having the eye hurt by an unguarded finger-bump, and the attendant is spared the discomfort of putting the hands into the liquid.

Madame Bonsignorio, p. 200, in giving the indications for heat and cold in ocular therapeutics, says that, generally speaking, heat is sedative and calming, but should never be applied when there is much secretion present nor when there is edema of the conjunctiva. She classes in six categories the eye affections to which heat and cold are appropriate:

1. In the diseases *a frigore;* iritis, vernal catarrh, *heat.*

2. In other forms of conjunctivitis, *cold.*

3. In corneal infections with edema, especially in serpent ulcer, *cold.*

4. In inflammations of the appendages of the globe, such as phlegmon of the orbit, abscess of the lids, and acute dacryocystitis, *cold.*

5. In glaucoma and retinal hemorrhages, *heat,* moderate and prolonged.

6. In the deeper inflammations, where there is no tendency to suppuration, like papillitis, chorio-retinitis, cyclitis, and iritis, *heat.*

Most authorities have written that heat is better applied for a longer time than is cold. With this I do not agree, but rather believe with the minority that short sittings of intensely hot applications have much the same effect as prolonged ones of cold. Three to five minutes of the first will accomplish more good, however, than one hour of the second, or than one-half hour of the *first.* Certain it is that fomentations should not be kept on for twenty and thirty minutes each, and thus kept up for hours. The effect is then much like that of a poultice, and this we all know to be bad. In general, I prefer short sittings for the hot applications—three to ten minutes, as hot as can be borne—115° to 125° F. for the moist, somewhat higher for the dry, and with intervals not too short—not over four to six in twenty-four hours, unless there is severe pain which is relieved by the heat. The intervals may then, in a measure, be regulated by the paroxysms of pain.

Massage.—As it relates to the surgery of the eye, this mode of treatment is useful mainly in connection with paracentesis or iridectomy for glaucoma. It is, however, a most valuable and important accession to ocular therapeutics in general. Its principal virtue seems to lie in the clearing and quickening effect it has upon the local lymphatic and venous channels. Massage is ***plain***, or ***medicamentous***, ***manual*** (*digital*, rather, as concerns the eye); ***instrumental***, that is, when an implement of some sort, as a glass rod or a swab, intervenes between the hand and eye; ***mechanical***, as when made by a vibratory machine; and *electric*, as when performed with the electrode of a galvanic or other current. The technic of digital massage is given in the chapter on paracentesis of the cornea, and that of instrumental in that on the surgical treatment of trachoma.

Tissue Injections.—Among the varying therapeutic tissue injections practised in ophthalmology are the *hypodermic*, or *subcutaneous*, the *intramuscular*, the *sub-conjunctival*, the ***sub-tenonian***, and the *intraocular*. They are all made by means of the ordinary hypodermic syringe. The simplest and best form of this instrument is that in which all is of glass save the needle. The barrel has a scale of minims marked on its exterior. The inner surface of the barrel and the outer surface of the piston are ground so that they fit exactly one upon the other. The nub at the extremity of the

barrel is threaded to screw into the needle. Such a syringe will stand all standard means of sterilization, and may be kept ready in a strong antiseptic solution. The needle is of platinum, is kept scrupulously sharp, and is sterilized by boiling. The socket contains a soft-rubber washer to prevent leakage. To use, the barrel is filled before the needle is screwed on, then, having put the needle on, the latter is pointed straight upward to expel the air. Enough of the liquid is then shot back into the receptacle to bring the piston to the proper mark on the graduated scale. The hypodermic injection is administered by picking up a fold of skin and plunging the needle into the fold coincident with its long axis, and so as to just miss the tips of the thumb and finger holding the fold, and the fluid is forced slowly in. The plunge of the needle is positive and quick—not hesitating and slow. In this way one gives strychnia and other stimulants to overcome the evil effects of narcotics and shock in the operating-room, and morphin for its quieting influence and for the pain after the operation. It matters little upon what part of the body the fold of the skin is chosen. Having withdrawn the needle, the part is gently massaged to favor quick absorption. It goes without saying that for any form of tissue injection the parts involved are aseptically prepared. In the intramuscular injection the chosen muscle is suddenly and deeply stabbed with the needle, avoiding the larger blood-vessels and the underlying bone. This is the kind usually employed for the administration of solutions of the mercuric salts for their constitutional effects. For the subconjunctival injection the eye is washed, douched, and cocainized. The lids are held apart by an assistant with fingers or retractors or by the blepharostat. The patient is directed to look up, a vertical fold of conjunctiva is picked up with broad-jawed fixation forceps, just below the cornea. The needle is passed into the lower half of the fold, tangential to, but not hugging, the globe, and pointing somewhat downward. The contents of the syringe, usually some 10 or 12 minims of solution, are then exhausted, causing a large bleb of conjunctiva to rise. The syringe is withdrawn, the lids carefully closed over the bleb, and the eye bandaged. This is the form employed in the less virulent infections of the globe after operations, for the local effects of mild antiseptics, like weak salt solutions and mercuric solutions. The most all-round satisfactory solution

in mild cases is the physiologic salt. It is followed by little disturbance when used alone, and is not so painful nor so apt to result in small round-cell infiltration of the conjunctiva as are the stronger salt solutions. None but chemically pure salt is admissible. They are specially useful in the treatment of the lingering forms of uveitis following certain extractions, and certain iridectomies for chronic irritative glaucoma, particularly those characterized by recrudescences. The subtenonian injection is, as its name implies, into Tenon's capsule. Another name is *intracapsular* injection. It is one of the sheet anchors in the treatment of severe septic infection threatening panophthalmitis. The eye is prepared and the lids held apart as for the subconjunctival injection. Cocain, however, often has little effect, owing to the hyperemia and inflammation that are apt to be present, so that it is advisable in cases of very sore eyes and demoralized patients to narcotize with nitrous oxid. The bottom of the external conjunctival cul-de-sac is seized with strong fixation forceps in such a way as to include a fold of the outer check ligament, the eye being meanwhile in adduction. This is drawn forward (upward, one might better say) and the needle passed backward, deep into Tenon's capsule, following the sheath of the external rectus. The regulation dose with us consists of 12 minims of 1% salt solution in which are dissolved 1/100 gr. of mercuric cyanid and 1/25 gr. of dionin. A small dose of acoin or morphin is sometimes added to alleviate the suffering that is almost inevitable afterward. Dionin has come to be regarded as an almost necessary ingredient of the last two forms of tissue injections. It adds greatly to the local disturbance which ensues. In fact, the reaction is often so great, and of such a character, as to be positively scarey, especially to a novice. Fortunately, the benefit is, as a rule, commensurate with the reaction, and the latter is, therefore, welcomed. A subsequent injection is not given until the visible results of the previous one have passed away, except in desperate cases. Between mildly reacting injections 2 days, and between the severer ones four to six days, is about the average time—but if speedy loss of the eye is threatened, they may be given daily. If the pain during the reactive stage be great, fomentations as hot as can be borne, are applied to the closed lid, and hot douches to the conjunctival sac. The therapeutic value of these subcon-

junctival and intracapsular injections is due, in all probability, to several causes—partly to osmosis, partly to local antisepsis, and largely to local counter-irritation, and, when dionin is present, also largely to their lymphagogue properties. Intraocular injections are such as are employed in artificial ripening of cataract—into the lens substance—and, in detachment of the retina—into the vitreous or beneath the retina. They cannot be called true and tried measures and have no real place here.

Blood-letting.—This venerable therapeutic measure seems now to hold a higher place in ophthalmology than in any other department of medicine. This is true, at least, of local or topic blood-letting. General blood-letting, or *venesection*, is now often resorted to in the treatment of the eye, and it is regaining some of its ancient prestige at the hands of the *internists*. It is especially valuable for lowering high blood-pressure before operations for cataract and glaucoma. Other names for the last mentioned are *phlebotomy* and *arteriotomy*, as indicating whether a vein or an artery is opened.

The Operation of Venesection or Phlebotomy.—The patient should be seated in a chair or in bed, rather than recumbent, especially where marked effects are desired, as the more rapidly the blood is abstracted the less will be required to lower the force of the circulation. Standing might induce syncope prematurely, while the prone position might allow too great an abstraction of blood before syncope which is Nature's danger signal, had been produced.

Septic phlebitis is the most serious complication to be feared after phlebotomy, and should be guarded against by rigid asepsis. The hands of the operator, the instruments, and the field of operation having been rendered thoroughly aseptic, a bandage or cord is tied about the middle of the upper arm, with moderate firmness, so as to arrest the venous flow without interfering with the arterial. Grasping a stick, or roll of bandage, or merely closing the hand tightly will then cause the veins to become prominent (Fig. 31). The median basilic is now fixed by pressure of the left thumb, and, with a sharp cataract knife or bistoury the vein is opened (not divided) obliquely to its long axis at about its middle point. The middle portion of the vein is chosen as being farthest removed from

the brachial artery on the outer side and also from the internal cutaneous nerve on the inner side. The first is separated from the basilic vein only by the semilunar fascia of the biceps tendon, and may be located by its pulsation, and the second lies on top of the vein, just where it joins the common ulnar vein. Blood will probably flow from the wound in a full stream; but if it does not, bleeding may be promoted by alternately opening and closing the hand. The blood should be collected in a graduated bowl, so as to estimate the amount withdrawn. Ten to twenty ounces will be necessary. It is best to have a sphygmomanometer attached to the opposite arm so as to measure the blood-pressure from minute to minute. The pulse will also indicate when the requisite effect has been produced. When this is accomplished apply a dry aseptic compress, and secure this by a figure-of-8 bandage around the elbow, and place the arm at rest until the wound is healed. Occasionally neuralgic pain is caused by the implication of some of the fibres of the internal cutaneous nerve in the cicatrix.

FIG. 31.

1, Opening in median basilic vein. 2, Median cephalic vein 3, Median vein 4, Basilic vein. 5, Internal cutaneous nerve. 6, Brachial artery. Only the semilunar fascia of the biceps separates median basilic vein from brachial artery.

Local blood-letting, as practised by the eye specialist, consists in extracting quantities of blood, varying in amount from 1/2 oz. to 2 oz., from a limited area external to the outer canthus by means of leeching. The leech may be natural or artificial. The best natural leech is the Scandinavian variety, which is to be had in most of the larger pharmacies. Each one is capable of drawing nearly 1/2 ounce of blood before becoming gorged and letting go. Two of them are sufficient, for if it is desirable to abstract more than 1 oz. one may increase the quantity to the proper measure by encouraging the *after-bleeding*. This will, in many instances, continue till made to stop, which is easily accomplished by holding a tiny bit of absorbent cotton tightly on the bite with the finger.

The bleeding having ceased, the cotton is left sticking to the spot. Preparatory to either mode of leeching, the temple is rendered aseptic. Unfortunately, the natural leech cannot be sterilized, but, fortunately, it is naturally a cleanly thing, even if it does live in mud. The most suitable place to apply the leech, either living or artificial, is that which is on a level with the outer canthus, and just external to the outer rim of the orbit. When two or more leeches are applied their heads are placed close together and in a horizontal line. One who is experienced in applying the leech can guide the animal's head accurately to the point selected for the bite by holding its body in the folds of a napkin. The tyro would better use a leech-tube. Into this the leech is dropped,

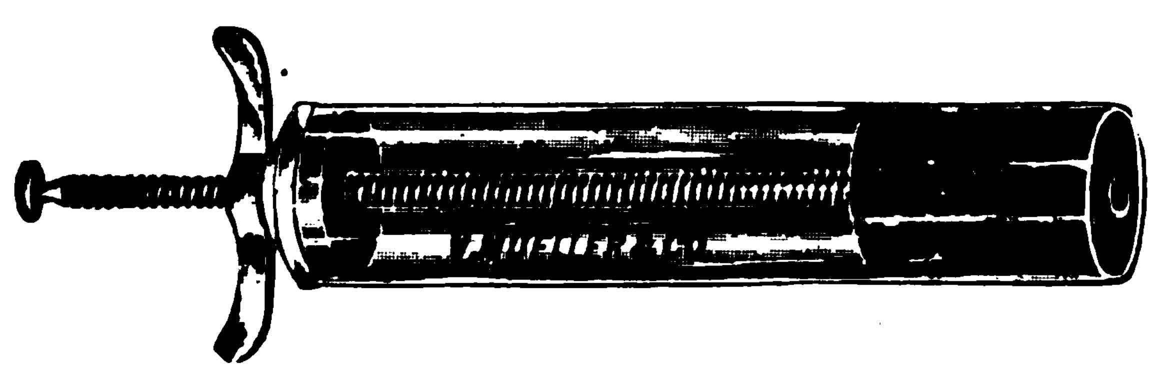


FIG. 32.

big end first. The mouth is in the small end that is forever reaching out. If the leech does not take hold readily, lightly scraping off the epidermis with a scalpel or putting a drop of milk on at the spot will induce it to do so. Having once begun to draw blood, it is allowed to remain attached till it falls off. The used, or "stripped" leech is never so good as a fresh one. There are several kinds of artificial leeches. The one bearing the name of Baron Heurteloup is still the favorite. Recently the elaborate scarifier that formerly went with it has been omitted. The leech is shown in Fig. 32. It consists of a metallic piston with asbestos packed head fitting very tightly in a glass cylinder and worked by a thumb-screw. The skin is scarrified at the point indicated for the leech-bite, the free end of the cylinder is moistened, applied to the part, and the air gradually exhausted by turning the screw. The relief and the improvement that result from leeching are often remarkable, though not usually immediate; from 6 to 24 hours may elapse before the benefits are apparent. It is difficult, therefore, to conceive of the *modus operandi*. Can it be the mere topic depletion

whereby the pain is relieved by freeing the sensory end-bodies fror pressure, and the inflammation reduced through quickening th circulation in the blood and lymph channels by the ensuing relax ation? Hardly. The natural leech seems to be more effectiv than the artificial, and for this reason I have sometimes wondere if it were not because of its more potent psychic effect.

CHAPTER II.

INSTRUMENTS AND THEIR MANAGEMENT.

"Ils doivent être, pour le praticien, des objets sacro-caints; des objets auxquels il ne laisse toucher personne de profane, qu'il considère lui-même avec amour à cause de leur perfection, avec respect à cause de leur destination. Il apportera le plus grand soin, non seulement à leur *choix*, mais aussi à leur *entretien* "—*Landolt.*

"They should be for the practitioner, objects almost sacred; objects not to be profaned by vulgar hands—that he regards with fondness because of their perfection, and with respect because of their destination. He will exercise the utmost care not only in their selection, but also in their maintenance."

Thus wrote my friend and teacher, over twenty years ago, in a little work called "A *Box* of *Instruments*." While with him, he commissioned me to translate it for publication in this country. I sent the English version to a friend in New York who consigned it to oblivion as concerned the ophthalmic world, by turning it over to a journal for general medicine. It was deserving of a better fate—by reason of its subject matter. This, then, would seem a fitting time and place to revive some of the excellent precepts and principles embodied in that book, and to add thereto whatever seems appropriate, in order to bring the subject abreast of the time.

The word ***management*** in the above caption refers to both the ***manipulation*** and the *care* of instruments.

First, as to the instruments themselves: What are the qualities requisite and desirable in them? This is a broad question and one of many sides. I shall attempt to answer it, not assuming the rôle of an oracle, but as one who has taken an active interest in the matter, both practical and theoretical, for the past two and one-half decades. Much has been written concerning the instruments of the "Vienna School," of the "Parisian School," of the "Berlin School," and of the 'London School," but little concerning the "*American School*"; therefore, an effort will be made to show also something of

what our countrymen have done in the line of surgical instruments for the eye specialist. Of the myriad instruments that have been conceived as applicable to ocular surgery, the vast majority have not stood the test of time; and it is, after all, remarkable how few really *are* necessary or desirable. Every surgeon and every maker of surgical instruments, even down to every salesman, has his own ideas on that point. The writer has great respect for the peculiar notions of others, especially, in this instance, if they be those of a *confrère*. So long as his work comes up to the standard, no matter how peculiar his notions, all honor to him. But his implements may not be above criticism. As to the maker, he is prone to regard the matter solely from a mechanical standpoint, without taking into consideration the human element that figures so largely in the material upon which the instruments in question are employed. With regard to the salesman—well, his business is to sell; and as a proof that he fully understands his business, witness the manner in which he beguiles the artless and aspiring tyro into stocking himself up with a lot of junk.

The first great requisite in any mechanical contrivance is *efficiency*, but the maximum of efficiency should be attained along with the maximum of *simplicity*. And surgical instruments are, perhaps, peculiar in demanding the most rigid enforcement of this law. These are the key-notes Close after them come such other attributes as grace of outline, delicacy of parts, and elegance of finish. They should be simple in the sense of being uncomplicated, as also in that of being plain. These properties are conducive to both cleanliness and dexterity--hence, to safety and success. They should be as light as is consistent with adequate strength, which is also an advantage in their use; hence, the need of delicacy of parts. And they should be pleasing to the eye—of their possessor, at least. This were argument enough for the grace of outline and the elegance of finish; but there are decidedly practical reasons also. One is actually capable of better effort when there is present a conscious pride in his means; again, the smoother and truer and brighter the surface, the easier to maintain, therefore, the demand for attractiveness.

Another most excellent thing in connection with the operative equipment—especially of the oculist—is a certain uniformity, or

harmony, of the corresponding parts of the different articles. In the form and size of the handles, for example, as also in the size of scissors rings, the length of scissors branches, and in the angle at which the blades of keratomes are set. To be sure, this cannot be carried out to the letter, on account of the inevitably great difference in bulk. But most of the smaller instruments in daily use can be made to conform to this principle. There are undeniable advantages in the habitual *feel* of the instrument imparted to the fingers in this way, not to speak of those as to appearances, that such a collection would enjoy over a heterogeneous assortment. Among the most obvious essentials in all instruments is superiority of material. This is especially true of the cutting instruments. Unfortunately, this is a quality of which it is difficult to judge beforehand. A few years ago all of our finer steel instruments were made in Europe, and the names of Collin, Lüer, Richter, Windler, Weiss, and a few others were not merely guarantees of high quality, as they are still, but they were *the* and *the only* ones. Now good and bad instruments are made "all over," and one may take his chances. Certainly the best of those turned out in the United States are second to none.

Thus, in a general way, is answered the question as to what are the qualities requisite and desirable in a surgical instrument. And what is true of these as a whole is true of those pertaining to any branch. Now, to particularize.

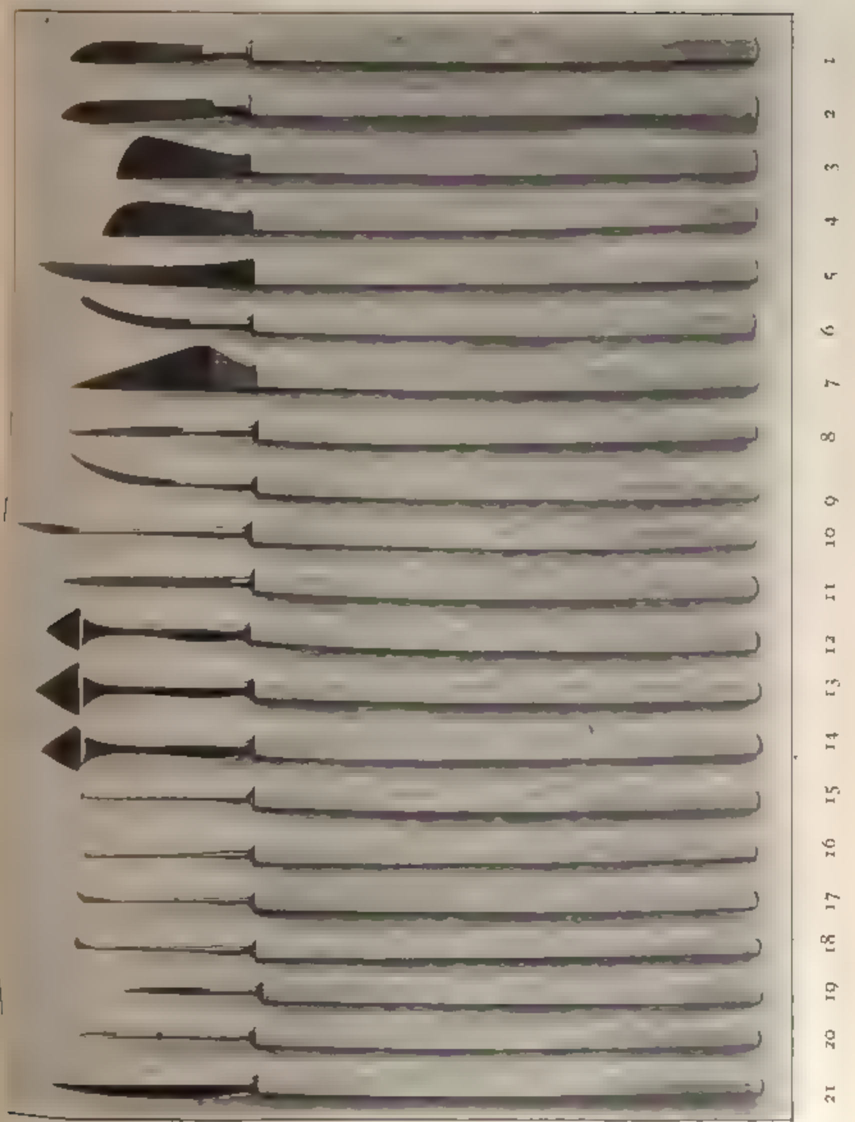
Following Landolt's classification we shall begin with the instruments with handles. "And in passing, let us bestow a word upon this feature of the instrument—a feature of greater importance than many seem to think. Is it not the intermediary between the hand that guides and the part that engages? Is it not through it that the sensitive fingers of the operator are made aware of the resistance their movements encounter; these fingers which put in touch with the work the reason that contrives, the intellect that seeks, and the power that executes?"[1] The handle was formerly made of ivory or bone, but these materials have now, quite properly, yet reluctantly, been discarded for metal, such as aluminum, to admit of boiling. Yet ivory is an ideal material. Its weight is just right. It is a poor conductor of heat and cold, and its best

[1] Passages in quotation marks are Landolt's.

DESCRIPTION OF PLATE I.

1. Arlt scalpel, medium.
2. Arlt scalpel, large.
3. Beard scalpel, extra convex.
4. Beard scalpel.
5. Sharp straight bistoury.
6. Blunt curved bistoury.
7. Beer (or Barth) knife.
8. Weber lacrimal knife, straight.
9. Weber lacrimal knife, curved.
10. Agnew lacrimal knife.
11. Graefe knife.
12. Bent lance keratome, small.
13. Bent lance keratome, large.
14. Bent lance keratome, medium.
15. Neuter cystotome.
16. Graefe cystotome.
17. Knapp cystotome.
18. Beard cystotome.
19. Pagenstecher knife needle.
20. Knapp knife needle.
21. Beard blunt dissector.

PLATE I.



quality is a peculiar adhesiveness. "Clings to the fingers," as Landolt says. Their rectangular, or rather, octagonal form has, with equal propriety, been retained. The classic form is that of a slightly fusiform, quadrilateral beam with chamfered edges. The heaviest part of the beam is at the junction of the first and middle thirds, where, in cross section, it measures 4.5x6 mm. From here it gradually tapers to either extremity, where the cross sections each represent a rectangle whose sides are 3x4 mm. for the free end and 3.5x4.5 mm. for the other—not allowing, of course, for the chamfer. The regulation length is about 10.5 centimeters. This size and shape are common, or should be so, to knives, including lances, to needles, knife-needles, cystotomes, hooks, curets, wire-loops, spatulas, spoons, spuds, and retractors. There are several reasons for its existence: First, it is handy to hold and to manipulate, adapting itself nicely to the pulps of the fingers. Second as all the working parts are attached with their flats in the same plane as the greater transverse diameter of the handle, one feels, in turning the handle on its long axis, just how much rotation he has imparted to the instrument. This is of the greatest value in such acts as the making of the corneal section, and in the cystotomy of a cataract operation. One can always know the position of the blade or other implement by noting that of the greater width of the handle. The edge of the blade or the point of a hook moves in the sense of the greater width. Moreover, the name of the maker is supposed to be stamped on the side o the handle that corresponds to the back of the instrument, so that, unless it be a blade with double edge, an additional, and often serviceable, sign is given. Landolt suggested that, while none of these instruments should have *round* handles, the sides should be equal (square in cross section) on instruments one of whose offices is to rotate in working, such as cystotomes and needles. It is just as essential to know the position and direction of the blade of a cystotome as that of a knife. It often disappears behind the iris, but one can be absolutely guided by the two lateral dimensions of the handle, in applying the point to the capsule, and in giving those two quarter turns that are such an important part of the capsulotomy. The little difference in the two opposite sides does not interfere with rotation. Then, as to the needle, it, too, has its blade—a double-edged one. It is the proper thing to withdraw

it from the anterior chamber, for instance, in the same sense that it entered; but, with the blade hidden in an opaque lens, as is often the case, and the aqueous most likely evacuated, this would not be so easy if there were not the handle to point the way.

So much for the handles. Next, for the instruments which they carry, together with a few notes as to their manipulation. Let us begin with the

Scalpels.—Of these there should be at least two—one after Von Arlt's model and another with a blade of great convexity. Arlt's is excellent for use in many ways, yet the other, while just as good for all around work, is superior under certain special conditions. The knife in question is one devised by the writer about twelve years ago, though the latest modification of it has even greater convexity of edge. Originally intended mainly for use in blepharoplasty, it has become my chosen knife in most instances where a scalpel is needed. It owes its individuality and its value to the extraordinary convexity of that part of the edge which is situated near the extremity of the blade. The length of the latter is about 2.5 centimeters, and its width, at the broadest part, 7 to 8 mm., while Arlt's is 3 to 3.5 centimeters long, and its greatest width is 5 to 6 mm. With the ordinary scalpel, held pen-holder fashion, according to rule, and with incisions of average penetration, the extent to which the edge engages the tissues is very slight, being limited to the point and several contiguous millimeters. Even with the handle as near as possible to the horizontal as is consistent with this manner of holding the handle, the length of available edge is less than one-fourth of the whole. Therefore, as regards the cutting qualities of any but the terminal third of the blade, it were as well that they did not exist. It is desirable, then, that the trenchancy of the part concerned be heightened in the utmost. This is precisely what is aimed at in this scalpel. A single point, like that of the bistoury or the Beer's knife, is insufficient, for the reason that it soon loses its keenness; whereas, the extended contact unavoidable with an edge of low convexity, is yet more unfitting, because it is less guidable and requires more force on account of the friction. The special configuration of the blade under consideration offers an efficient mean between the two extremes. If held fiddle-bow fashion, as would seem to be the preferable

for its use in general, its incisive qualities are truly remarkable. It has the added property of being able to cut nearly as well in *pushing* as in *pulling*—a veritable fiddle-bow action. With it such measures as the Streatfield counter-grooving of the tarsus, the intermarginal incision to receive the graft in restoration of the free border of the lid, etc., are particularly facilitated. The custom of making the free extremity of the handle into a blunt dissector or of making "double-header" instruments of any description is to be decried as not in keeping with advanced ideas. Besides, there is little to be gained in time or convenience by their use. Who has not seen in the well-known Daviel's spoon combination the persistence with which the cystotome member tried to get caught into things while the spoon member was occupied? The very diminutive scalpels often seen may have a place in ophthalmic surgery; if so, the writer has never found it.

Bistouries.—Two of these also. One having a long, straight-edged blade, with good, stiff back, joined to the handle by a strong shank, for work such as deeply thrust incisions for orbital cellulitis. The blade should be at least 4 centimeters in length, and 1/2 centimeter wide at the hilt, gradually tapering, by the back, in a slight curve to the point. The other smaller, with blade curved, concave on the edge, and extremity neatly blunted. Its length should not exceed 3 centimeters, and its greatest breadth, which is also at the base, scant 3 mm. This has been called a probe-pointed bistoury, and is most useful in enlarging openings, or fistulous tracks, into suppurating cavities, or leading to foreign bodies in the orbit, etc. It would also answer, in a pinch, for extending an inadequate corneal section in extraction.

Beer's Knife.—One of these is sufficient, and it should be of the true Beer, or, rather, Barth, pattern, i.e., not of convex edge, like the old Béranger cataract knife, but straight both edge and back, and somewhat smaller in all dimensions than that of Beer. Three centimeters long and 8 mm. at the widest point is ample, whereas the original was 4 centimeters long by 1 centimeter for the rise of the hypotenuse. Although no longer employed in the capacity for which it was intended, yet for the incision of hordeola, and of chalazions by the Agnew method, through the border of the lid, there is no knife its equal.

Lacrimal Knife.—Owing to the few occasions, these latter days, for Bowman's operation, a single representative of this class is enough; and my choice would be for that of Agnew. The blade, including the probe, is 1 1/2 centimeters, of which the probe and its neck comprise a trifle more than one mm. The back has a slight convexity, and the edge a more decided one. The greatest width is at the middle, where it measures 2 mm., and it is connected with the handle by a round, malleable iron shank, about 3 1/2 centimeters long. The object and advantages of this last feature, in adapting the knife to the overhanging brow and permitting of its entrance into the nasal duct, are too well known to dwell upon. The Weber knife is lacking here, and the neck of its probe, being too long and curved, renders it liable to snap off in the tissues.

Graefe Knives.—One could manage to get on with three cataract knives, provided he were within convenient distance of a reputable instrument maker or repair shop, but from four to six would not be considered an excessive number. Graefe knives, in common with all keratomes, are the most exacting of all the ocular instruments as to their keeping. This is especially true of the point. No matter how faultless the edge, if the point is not perfect the instrument, for the moment, is worthless. So exceedingly delicate is it that the merest touch against the box in which it is kept, or against the tray or dish in which it is cleansed, or against the towel in wiping it, and it is out of service. For these reasons it is advisable to have a reserve supply, and, in preparing for an extraction or iridectomy, to make ready two such knives lest one should come to grief. The blade of the most approved model is 30 to 32 mm. long, full, strong, 2 mm. wide at its base, where it joins the shank; at this point also it is full 1/2 mm. thick, and from here both width and thickness decrease by insensible degrees toward the extremity, till, within 4 or 5 mm. of it the width is reduced to less than 1 1/2 mm. From here the lines converge, in a slight curve, to form the point. An error, often found in connection with the Graefe knife, is that the more pronounced narrowing of the blade begins too far back, and that, instead of the opposite sides approaching in the correct outward sweep, they do so in straight lines. This makes a long, needle-like point, that is extremely frail and difficult to keep in order. On the other hand, too abrupt a termination, while not so

objectionable as the kind just described, is also objectionable in that it lacks penetrating qualities. These defects are more apt to be acquired at the hands of unskilled repairers than to be present in the new instrument. The back is scrupulously rounded. Blade and handle are connected by a pedestal-shaped shank fully 1/2 centimeter long, which must be strong and firm.

Lance Keratomes.—It would be well to have not less than four, say two with blades of average dimensions, the third of somewhat larger, and the fourth of smaller measurement. This knife is usually referred to as *the* keratome, and, although strictly speaking, it is not any more of a keratome than any other knife that is used to incise the cornea, usage has made it more entitled to the name than the others. Its origin was, in England, as "the bent lance," and it came to be known in Europe as the "English lance-knife." It has undergone many modifications and been put to many uses. The present model is essentially that given by Friederich Jäger, and its employment is almost exclusively confined to corneal incisions for iridectomy and, in short, all operations requiring a linear, corneal opening, of relatively limited extent. Czermak recommends it for making the intermarginal incision in restoration of the border of the lid in trichiasis. The blade is almost an equilateral triangle, the measurement from heal to point in the median line, constituting the altitude, being greater by one mm. than that across the base. The dimensions of the average size, of which it is well to possess two, would be 9 mm. for the base and 10 mm. for the altitude. Those of the other two 7x8, and 10x11 mm., respectively. Jäger's blade was set at an angle of about 45° to that of the handle. This has been found too great a bend for any but the most deeply sunken eyes. The most convenient angle for all around utility is about 35°. And I quite agree with Knapp in recommending, as has been stated, that all the keratomes be set at the same angle. These four, at any rate. On rare occasions a narrower and comparatively long blade, and an ordinary one, of good size, mounted on a bayonet shank (Bader's) would come handy—the first, for instance, in certain optic iridectomies, and the second for extraperipheral iridectomy in a subject with great overhang of brow. Landolt's well-known keratome with the broad curved shank, and the blade with rounded corners, is a practical instrument, but as it requires

special manipulation because of the peculiar construction of the shank, one should have either all or none of this style.

Cystotome.—One is a necessity—two would be almost a luxury. Those in the market are mostly modifications of Von Graefe's. It would be better if they were the original model, for it is a splendidly conceived instrument. The outline of the blade is very suggestive of the side view of a goose's head (Fig. 33) It will be observed that the back of the head of the goose is well rounded, and that the throat, from beak to neck, is a light concavity. Now, what passes in this country as the Graefe cystotome is commonly an ugly, angular affair, something like that shown in Fig. 34, being a mere spike, or peg. The back of the head is a right angle that

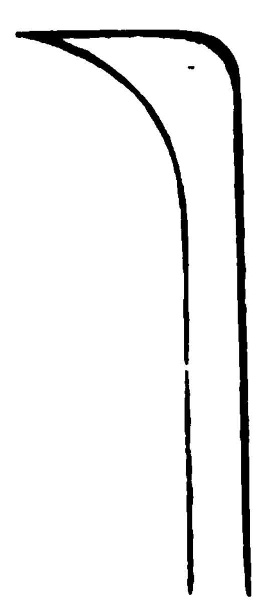


FIG. 33.

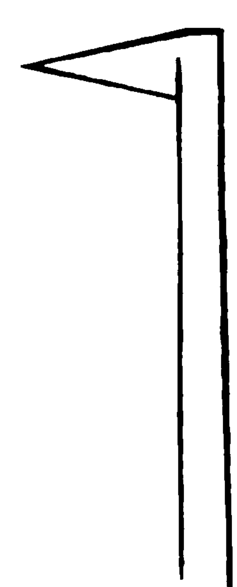


FIG. 34

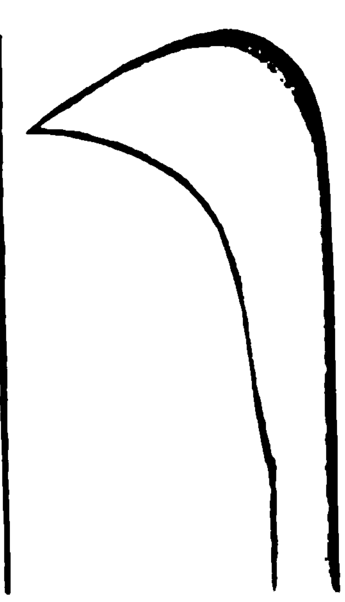


FIG. 35.

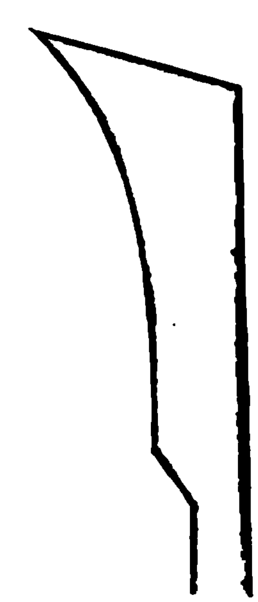


FIG. 36.

catches in the incision and in the iris; and the throat is another angle in which rust and bacteria can accumulate. The idea seems to prevail that only a scratching point is required in a cystotome—that a cutting edge is a superfluity; and, doubtless, many a bungling capsulotomy is the result. A mere point does not *cut*, it simply *tears*. The point punctures the anterior capsule, and, unless there is an edge, and a sharp one at that, to make an incision, the alleged capsulotomy is nothing but an indiscriminate laceration. Knapp's cystotome is an example of an incisive one, but it too is objectionable by reason of its angularity. Someone has given to the Graefe cystotome a small cutting extension backward which adds to its efficiency. The author has used for the past ten years a cystotome on the Graefe principle, only the head of the goose is larger, and the trenchant part is prolonged a little way into the neck (Fig. 35).

Continuing the simile, the tip of the beak is on a lower level than the top of the head. In other words, the back of the blade is a parabola. This disposition of the point makes it easier to introduce and to push beneath the iris than if it were on a level, as is the Graefe cystotome, or actually in advance of the rest of the blade, as in the Knapp (Fig. 36). From the back of the head to the tip of the beak is 2 mm. The center of the crescent that constitutes the blade is 1 mm. wide, or even 1 1/2 mm. The shank measures 22 to 25 mm. The objects in having it larger than the Graefe are to make of it a cutting instrument of greater significance, thereby enhancing the precision with which it can be guided and inspected, and, in a measure, to forestall the ravages of those who afterward put it in order. One *grinding* will often reduce a smaller cystotome to a bare remnant, and leave no semblance of its former shape This instrument is not so large, even at the beginning of its career, as to make its size an objection. Of course, it is not presumed that the entire edge of the blade will engage in the capsule at any one operation, but it is there, and ready to cut, if called upon. Contrary to what has been said relative to the length of blade in the cystotome, I have noted, time and again, both in operating upon pigs' eyes and upon the human subject, that the tiny spike of the pseudo-Graefe instrument, especially after a few improvements (?) at the hands of the sharpener, failed to so much as touch the capsule in places. With the anterior chamber empty, and the lens bulging forward, its anterior convexity is rather increased, so that, with an insignificant blade, unless one takes pains to see that the point is applied, by lifting the handle, the shank will rest on the summit of the lens, in starting the capsulotomy, and the point be thus kept from reaching the capsule.

Knife Needle.—One of these would be thousands. Were this article to specify the model, it would be that of Knapp. Not the pigmy thing only 3 or 4 mm. in length one sometimes sees going under this name, but a blade of respectable proportions, or about 8 mm. long and 1 1/2 mm. wide. Nor should it have a shoulder, or offset, where knife and shank unite, as is most often the case. This goes with a jerk through the incision made by the knife. Pagenstecher's discission knife is also a first-class instrument, and is well suited for discission by the way of the corneal base, or

the *conjunctival route*, which is fast becoming the *only* method. The advantages of this mode, together with a method of preparing old worn Graefe knives for use in the operation, in place of needles, or knife needles, is given in the chapter on *Discission.*

Stop Needles.—The various types of discission needles, like the long, straight, spear-pointed, the sickle, etc., have mostly fallen into disuse. One among them, however, is still in favor. This is the stop needle of Bowman. As it owes its prolonged life to its value in the operation of *dilaceration*, it is best to procure a pair of them. In view of the fact that in this procedure the needles are passed through transparent cornea, they should be gotten up in manner so slight and dainty as to insure a minimum of traumatism. The little rhomboid terminations ought not to exceed 2 mm. in length by 1 mm. in width. It is best to have the edges lightly convex, as this not only helps in penetration, but also gives lee-way for sharpening without spoiling. The size of the shaft between rhomboid and shoulder should be 6 to 7 mm. long by 3/5 of a mm. in thickness, and the larger, or upper, part of the shaft should not leave off suddenly, leaving a square offset, but should taper—but rapidly—into the lower part. By this arrangement there is no sharp angle to catch dirt, no corner to injure the corneal epithelium, and, most important, the sloping shoulder serves as a stopper to keep back the aqueous.

Tattooage Needle.—This is an instrument seldom needed except in a large charitable clientèle, and there they are supplied. Besides, as the cases are not usually emergency ones, there would be time enough to get the instrument after getting the patient. However, the instruments for the procedure are described under *Tattooage of the Cornea.*

Blunt Dissector.—For shelling out tumors, extirpating the lacrimal sac—in short, for use wherever blunt dissection is indicated; also for loosening the periosteum in total exenteration of the orbit, the writer has had constructed a modification of Fenger's blunt dissector. Its blade is lanciolate, lightly curved on the flat, has a suspicion of transverse rounding out on the convex side, and a low, longitudinal, median rib on the concave side. Its length is 3.5 centimeters, and it is 6 mm. wide at its middle.

Sharp Hooks (Plate II).—One, or possibly two, of different pat-

terns, would be ample in this line. This is an instrument whose place, in certain emergencies, no other instrument can quite fill. There are two well-known classes of the sharp hook, viz., that which is very minute, and whose bend is short. This class, of which there have been a number of modifications, goes back to Beer. Its surviving representative is that which bears the name of Tyrrell, and whose crook is precisely like that of a button-hook. The other class is descended from the *vectis*, of Gibson, but is more closely identified with Von Graefe. Here the bend is either angular or but slightly curved and is much less acute. The first-mentioned kind was destined solely for an iris hook, and as such it has chiefly been used. If, however, it is given less of the backward bend, that makes it like a button-hook, and the crook is opened out somewhat, it makes an excellent instrument with which to deliver rather tough cataracts that are loosened and are well forward—generally more or less within the anterior chamber—yet, that it is not practicable to get out by pressure. The other hook has none of the backward bend in beginning the crook, but goes off from the shank almost at a right angle, and is very slightly curved. Its appearance is more that of an old-fashioned dissecting tenaculum in miniature. This is, by far, the most suitable instrument with which to go fishing for luxated cataracts that lie deeper, that is, behind the iris, and for the softer ones that are in the anterior chamber. It can be dug deeper into the lens, and more readily than the other, and if it becomes entangled in tissue that is not wanted, it can be more easily extricated. For remarks on its advantages over other traction instruments in cataract operations see chapter on the *Immediate Accidents* of Extraction. Suffice it to say in this place that, although it is a *simpler* matter to scoop out such lenses, along with other things, than to catch them deftly on the hook without disturbing the other contents of the globe, there can be little question as to which is the *better* method. Could I have but one of these hooks, I would choose the one last described. These hooks should be of the best steel, and exceedingly fine and delicate. The length of the more curved one ought not to be more than one mm., and that of the straighter should be 1 1/2 scant.

Blunt Hooks.—There are also two kinds of blunt hooks, but one kind and one hook is enough for anybody. Their only difference

DESCRIPTION OF PLATE II.

23. Bowman stop needle.
24. Tattooage needles, round form.
25. Tattooage needles, flat form.
26. Beard extraction hook.
27. Tyrell blunt hook.
28. Stevens squint hook.
29. Graefe squint hook, medium.
29′. Graefe squint hook, large.
30. Prince divulsor.
31. Silver spatula.
32. Tortoise-shell spatula.
33. Daviel spoon.
34. Bunge exenteration curet.
35. Pagenstecher extraction spoon.
36. Round curet.
37. Olive curet.
38. Saw-edge curet.
39. Beard exenteration knife-spatula.
40. Weber wire loop.
41. Snellen wire loop.
42. Grooved foreign body spud.
43. Flat foreign body spud.

PLATE II.

23 24 25 26 27 28 29 29' 30 31 32 33 34 35 36 37 38 39 40 41 42 43

is as to size. Both were designed as iris hooks, i.e., for catching the pupillary border, not as was Beer's, for catching in the stroma. The larger is attributed to Himly, and is about as lumbering a thing as can well be imagined. The other is known, in this country, as Tyrrell's. It is, truly, a tiny button-hook, seeing that it has not only the form, but the blunt point, as well, and is much more dainty than Himly's. In the sometimes difficult task of seizing with forceps the funnel-shaped iris of aphakial eyes, for instance, and for the extraction of some adherent and much shrunken cataracts, Tyrrell's blunt hook will come nobly to the rescue. Its form and its smooth, round point peculiarly fit it for its insertion and withdrawal through the corneal wound. The mode of using it is described under *Agnew's Blunt Hook Operation.*

Squint Hooks.—There are three standard sizes of such hooks, and at least one of each should be provided, for each size has its appropriate uses. There is a vast difference in the crooks of squint hooks. Some makers seem to think that all that is demanded is to give to a round rod of steel of definite size a given bend. But those who understand the exigencies of the instrument know that the correct fashioning of its working extremity is no mean job, either as to the configuration of the bend or as to that of the metal comprising the bend. The bend is far from a right-angle one, as has often been stated. It may be best described as an arc of a circle. True, the *chord* of the arc makes a right angle with the long axile of the stem or shank. And it must be insisted upon that the chord be that of a *true* circle—not of a parabolic curve. In the Graefe hook, which is the largest of the three sizes recommended, the radius of the arc is 5 mm., its height, or rise, is 2 mm., and the length of its chord, which, as said before, is at 90° to the stem, is 9 mm. In the intermediate hook—suggested, I think, by Landolt—the chord measures 7 mm., and in the smallest, that of Stevens, it measures 5 mm., the rise, and the radius being proportionately less The sides of the hook are flattish, i.e., in cross section the crook would represent an oval, whose short diameter is constant in every part of the bend, being about 1/2 mm. for the largest and the intermediate, somewhat less for the smallest. The long diameter of the oval in the Graefe hook, gradually increases from 2/3 mm. at the center of the curve, to 1 1/3 mm. at the free end, the

same being true, though relatively less, as to the other two. The extremities in all are smoothly rounded. This form gives a crook that is readily inserted beneath a tendon, is not so slight as to allow the latter to slip off easily nor so pronounced as to be difficult to disengage The Graefe hook is adapted to the work of picking up the tendons in enucleation, and that of holding the tendon, well spread out, for the placing of sutures, etc. The medium hook answers for the same purposes, but is better adapted to the picking up of the tendons in tenotomies and advancements. The Stevens hook is, preeminently, the hook for the partial tenotomy.

It is remarkable to what an extent the Graefe squint hook has become an all-around handy instrument. As examples of its uses are the following:

In extirpation of the lacrimal canal, if the hook is passed beneath the sac as soon as that organ is oposed, the dissection is greatly facilitated by working the hook up and down between cupola and the nasal duct. In the removal of the corneal portion of a pterygium it serves admirably as a divulsor. In the withdrawal of bits of iron or steel from the interior of the eye through a wound or incision, the hook may, on occasion, and with advantage, be inserted at the opening, then put in contact with the tip of the magnet, instead of introducing the tip itself. It is employed to express the lens in the extraction of cataract, especially in the "Indian" operation. It is frequently made to act as a retractor in holding apart the lips of incisions.

Iris Spatula.—The tortoise-shell spatula is an ideal instrument, and the hard-rubber one but little inferior. Unfortunately, they cannot be—at least, they are not—fastened to the metal handle in a manner that will allow of their being boiled. They can, of course, he made aseptic by other means, but there is a sense of security in being able to boil *all* the instruments, for a particular operation, that comes of no other method of disinfection, so that every one should be boilable. The best spatulas, to my knowledge, that conform to this principle, are those of silver and of gold. If of the last, in order to have the requisite strength and elasticity the fineness of the metal should not exceed 10 k. The blade, including the shank, is 3 1/2 centimeters long, and is 1 1/2 mm. wide throughout, and not more than 1/4

mm. in thickness at the middle. It should be lightly curved on the flat, and the edge thinned down to the point just short of trenchancy. The extremity should be rounded and, if anything, there should be less thinning of the edge at that point than along the sides, to prevent wounding the iris in poking. It must be seen to that the metal spatula does not have a wiry edge nor become nicked.

Extraction Spoons.—Here too it is a pity we cannot consistently enjoy the luxury of tortoise-shell, but we must content ourselves with either solid or German silver. Two are required—one for use behind the incision, the other to make pressure from below; the first flatter and broader than the second. The name *spoon* is really applicable to the model of this instrument only so far as it concerns the external form, i.e., there is no bowl to the spoon—it is solid or plain. They are not intended for scoops nor for curets. Earlier spoons had a concavity because they were used to scoop or lade out something—usually more or less of the cataract. Its presence, however, in the expression spoons of to-day is about as useful as the appendix or any other rudimentary organ; and also, like the appendix, it is simply a place for things to lodge. The outline of the spoons is like that of a pear, but, unlike ordinary spoons, the broad end is the one that is free. Their long axes measure about 8 mm. The smaller spoon measures 4 mm. at the widest place, and the larger 5. The smaller is a trifle over a millimeter in thickness, the larger, a trifle under. The back is a regular convexity, i.e., without a longitudinal rib, and the front is perfectly flat. The edge is faintly rounded and smooth. The broader spoon is the same as that of Weber, excepting that it is not hollowed out, and the other, very similar to that of Graefe, though, in addition to the concavity, the latter has a great curve in the shank that supports it. In the shank of each of those here described there is a gentle bend in its terminal third.

Curets.—Called also *Sharp Spoons*. Every outfit should contain several of them. One or two fair-sized ones for the curetment of granulating pus cavities, for example. If two, it were well to have one of them fenestrated, as this kind is easier both to clean and to sharpen. Obviously, it is not so well fitted for the double purpose of scraping and scooping. Then, too, let one be circular and the other oblong. Their greatest diameters should not exceed

seven mm., nor the smaller four or five. The depth of the bowl must not exceed 1 1/2 mm., and it is important that the edge should have a moderate flare. Then, a small curet with finely serrated edge for such work as the obliteration of the sac or cyst wall in the operation for chalazion and for getting rid of little islands of the uvea in exenteration of the sclera is invaluable. It may be either round or slightly oval, measuring about 3 mm. across. Without going too extensively into curets, one might also venture on the acquisition of one for loosening the contents of the globe in exenteration. The most suitable form for it would be oblong and thin, and with a decided flare to the edge. For this purpose the writer prefers his exenteration knife-spatula.

Exenteration Knife-Spatula.—This is an improved instrument invented by the writer[1] for the removal of the contents of the sclera in the operation of exenteration of the globe (Plate II). As its name indicates, it partakes in qualities and uses of both knife and spatula, being a little too dull for a knife, and too sharp for a spatula. It consists of two parts, a blade and a handle. The blade is double-edged, is about 4.5 mm. wide at its broadest part, where it joins the shank, and gradually tapers to the extremity, where it is neatly rounded. Its length is about 2.5 centimeters. It is curved on the flat for two-thirds of the distance from tip to base, to correspond to the meridional concavity of the sclera, and transversely convex on the outer surface to fit the equatorial concavity. Its inner surface is flat. The edges, while not so keen as is the edge requisite in a Graefe knife, are, nevertheless, tolerably trenchant. The rounded end is blunt—not bulbous—so that puncture of the sclera may be easily avoided The handle is of aluminum, to admit of boiling, and blade and handle are united by a nicely modeled shank.

Wire Loop.—This is sometimes referred to as *Fenestrated Spoon*, which is a very poor name, yet one sees now and then a wire loop so clumsy that it might well be thus designated. It is needless to state that the object of this instrument is the delivery of a cataract that is luxated or has dropped into the vitreous. Seeing that it is employed at a time when there is a large corneal incision through which the vitreous is either escaping or on the verge of doing so, it is of the highest importance that a wire loop

[1] Ophthalmic Record, July, 1905.

introduced to bring out the lens be so constructed as to cause the minimum of displacement. It must, therefore, be made of wire that is as fine as is consistent with the force exerted, and the spread of the loop must not be needlessly wide. If the wire is stiff and strong—as it should be—its diameter need not be more than 1/3 mm. The greatest width of the older Graefe loop, was at least 6 mm., and its total length was 1 centimeter. Weber modified the loop by simply stretching it out, as it were, making it 4 mm. wide and 1 1/2 centimeters long, but leaving the same coarse wire. Snellen, while adopting Weber's loop, reduced the size of the wire. Next to the open sharp hook, this is the best instrument for extracting lenses that cannot be expressed, and, in inexperienced hands, it is the *very* best. Snellen's modification of Weber's would be my choice.

Lid Retractors (Plate VIII).—For three score years the retractor of Desmarres has stood alone. Its inventor called it an *élévateur*, because it was originally destined for the upper lid alone. The only change that has been made is the accentuation of the bend, i.e., in the present model the hook of the lid-holder is not so widely open. The trough of the older retractor measures 1 1/2 centimeters across the top; in the newer model it is only 1 centimeter. It is better to have two of these, one for each lid of adults; a larger for the upper lid, the length of the trough of the lid-holder measuring 16 to 17 mm., and a smaller for the lower lid, with trough only 12 to 13 mm. The smaller will also answer for the upper lid in cases of small children. Those with heavily gold-plated lid-holders and shanks are preferable, and their cost is not excessive. Fenestrated retractors have no special advantages over the solid. It is always easy enough to turn the lids for inspection and treatment of the cornea.

A very objectionable feature often noted in connection with the handled instruments, such as lance keratomes, cystomes, spoons, curets, squint hooks, and wire loops, is the extreme length of the shank. A length of 35 mm. in this part is not uncommon, and even 40 mm. has been observed. To hold these properly by the handle places the fingers too far from the working part, too far from the eye operated upon, and from the patient's face. Twenty-two to 25 mm. is about the desirable length.

So much for the instruments of uniform handles; now for those with uniform rings and branches, or the

Scissors (Plate III).—In commenting upon incongruous types of scissors that one often sees in the oculist's kit, Landolt says, "Whenever we are confronted, among ophthalmic instruments, with the reminiscences of the grosser surgery from which ours sprang, it is most often in case of the scissors." What was true at the time this was written is true to-day. Not only are many of the scissors destined for eye surgery conspicuously coarse and big, but many of them—yes, the majority—are lacking in the quality of their steel, and faulty as to the articulation of the blades. As with the scalpels, it is mainly the terminal portion of the blades that is concerned while they are in use. But, if the coaptation of the blades is not perfect, it is just this part that suffers most. A defect that occurs with exasperating frequency is the failure of the edges to overlap, or pass each other, at the end of the blades, or "forking." This comes of the greater wear in this location and of the sharpener failing to adjust matters as he should. The instrument will have a longer life, without undue shortening of its blades if these overlap very decidedly when new. Landolt thinks that the automatic fastening is, in a measure, responsible for the inferior cutting qualities of some scissors. Arguing that, because of one's inability to tighten the fastening when the scissors get loose, as can be done with those that are joined by a screw, the only recourse is to cramp the blades by pushing forward the thumb ring and pulling back that of the finger. This may be true, but I have been unable to detect any difference in the working of the two kinds. The advantages are largely on the side of the automatic when it comes to a question of keeping them free from rust and filth—that much is certain.

With regard to the rings—these are supposed to accomodate, one the thumb, and the other, the third finger up to the first joint. They will then be large enough for any but digits of extra volume. The problem is solved by letting the regulation pattern conform to this principle and compelling the acromegalian to have his scissors made to order. With respect to the branches, there is no good reason why they, too, should not be standardized as to length, seeing that the variations in the dimensions of the blades are not

so great as to be in the way. With the thumb and ring finger inserted as stated, and the middle finger resting upon the outside of the adjacent ring, as is the correct position for holding the scissors, the length of the branches should be such as to permit the tip of the index to fall naturally upon the pivot of the blades. This means, for the average hand, a measurement of about 5 centimeters from the pivot to the junction of branch and ring. Any marked increase of this length tends to cause wabbling, and any material decrease restrains freedom of action through cramping the fingers. The scissors used by the oculist are all so small that whatever latitude is necessary in making the relatively slight differences in strength need not affect the aperture of the rings nor the length of the branches. It is merely a question of the *weight* of these parts and of the proportions given to the blades. Those that have branches 4 mm. wide by 3 thick, and blades 3 1/2 centimeters long, 8 mm. wide and 1 1/2 mm. thick at the base are strong enough for any of the usual work. The daintiest iris scissors have branches 2 1/2 x 2 mm., and blades 2 1/2 centimeters long, 5 mm. wide, and 1 mm. thick at the base. It follows, therefore, that there are no great differences in size after all.

A question that has often occurred to me is: *Why do so many pairs of scissors have sharp points?* The instrument does not advance by puncturing at two contiguous points, then uniting these points by tearing the intermediate tissue! The cutting point is that just where the edges intersect, which constantly moves forward as the blades are closed. The tissue that is being divided is caught in that angle. There can be no office for those needle-like extremities excepting to do mischief. They should be abolished. The tips would simply need to be blunted by slightly rounding them. It is even doubtful if there is now any branch of surgery in which incisions are made by first piercing the tissues with one sharp blade, then closing down the other to effect the cut. Formerly this was not an uncommon practice. It is at present confined to the trades. Neither is there any more a place for the elbowed scissors, with one blade probe-pointed, though they are still with us, *emeritus*, as it were. But enough of generalities. Let us make a few selections.

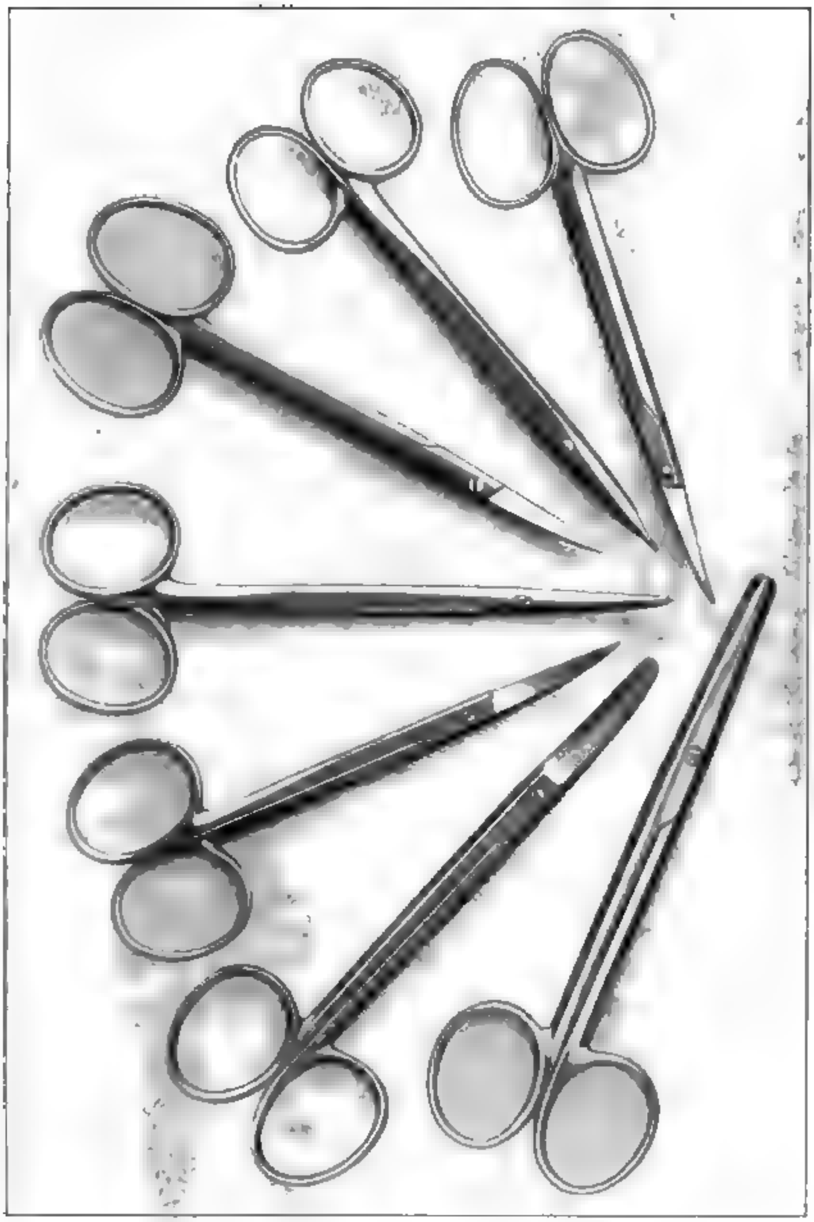
Strabismus Scissors.—Those generally acknowledged to be

DESCRIPTION OF PLATE III.

44. Strabismus scissors, small.
45. Stevens strabismus scissors.
46. Blunt strabismus scissors, medium.
47. Blunt scissors, curved, medium.
48. Sharp scissors, curved on the flat.
49. Enucleation scissors, medium.
50. Enucleation scissors, large.

PLATE III.

45 44



46 47 48

49 50

best adapted to squint operations are so small as to be only one grade heavier than the iris scissors described a little way back. They are lightly curved on the flat. To be more exact, the radius of the curve is 4 centimeters, and the bend is regular. This is a sharp enough curvature for any scissors—in fact, it is about what is proper for all of that character used in eye surgery. Yet one often sees them with a curve having a radius of only 3 centimeters. And, that the scissors may work smoothly and be easier kept in order, it is essential that the curve maintain about the same radius throughout. I say *about* the same, for it must be remembered that this cannot be mathematically true of curved scissors, as the curve of the inner blade must be a trifle greater than that of the outer. This is shown by the fact that when the blades are closed there is always a narrow, crescentic space between them. The blades of the strabismus scissors are about 27 mm. long, and 5 mm. wide at the base. From here they taper to the extremity, where the width of the two, with the scissors tightly closed, is one mm. and the combined extremity is nicely rounded. Broad, clumpy ends would better be rejected. In order to be strong enough, the base of the blade should be 1 1/2 mm. thick *plus*, and, at the end, fully 1/4 mm. This form of scissors has a more extended range of application than any other eye instrument, and one should possess at least two pairs, though it were well to have the second pair just a shade heavier—not longer. Stevens' strabismus scissors are useful but not notably better, for the work for which they were designed, than are those just described; and it even seems that, by reason of the peculiar narrowing down of their extremities, they "buckle" easily and are difficult to maintain.

Enucleation Scissors.—Having the last-named heavier scissors, a special pair, for cutting the optic nerve, are not really necessary. To sever it, together with the surrounding vessels and nerves, would put no strain on scissors of this strength. Yet it is perfectly fitting to get the extra pair. They should be but a trifle heavier than the stronger strabismus scissors. Their blades might be 3 centimeters in length, and their extremities a trifle broader. I have a pair that I purchased in Vienna, while a student there, the branches of which are 9 centimeters long and the blades 4 centimeters. The base of the blades is one centimeter in width. They were regularly sold

DESCRIPTION OF PLATE IV.

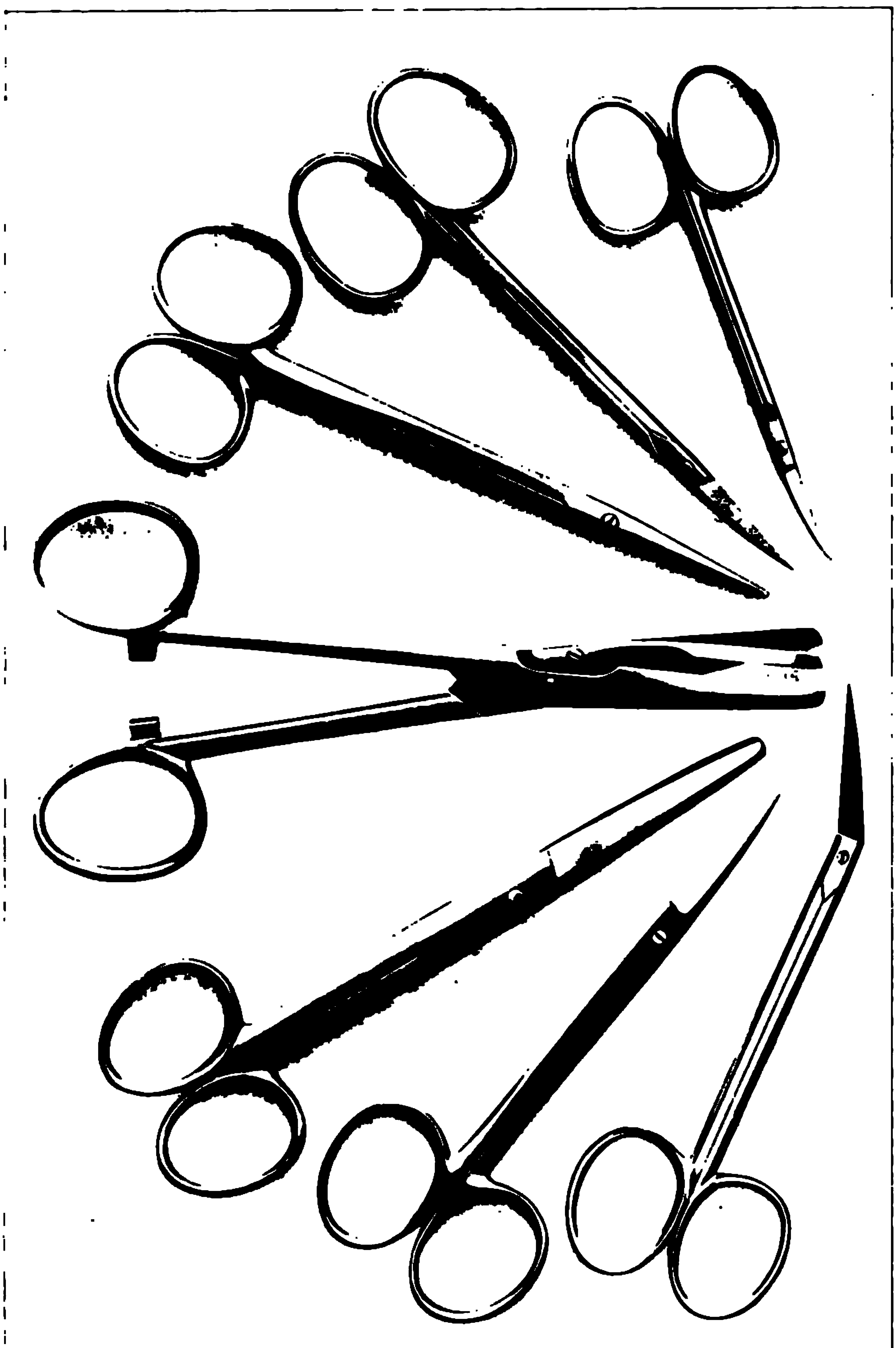
51. Small iris scissors.
52. Luër's iris scissors.
53. Straight blunt scissors.
54. Enucleation scissors with hemostatic clamp.
55. Canthotomy scissors.
56. Straight sharp iris scissors.
57. Sharp-pointed angular scissors.

PLATE IV.

52 51

53

54



55

56 57

for enucleation scissors. They look now as if they belonged to a veterinary kit.

Terson,[1] of Paris, is the originator of a pair of enucleation scissors that appeal strongly to one's sense of practicality and fitness (Fig. 37). The blades are perfectly smooth and slightly curved on the flat. They are of precisely the same lateral dimensions, so that when closed their borders are exactly even. Their extremities are broadly rounded. Their most striking peculiarities lie in the fact that the inner or concave blade is extremely thick, while the outer, or convex one, is proportionately thin, and that neither blade is beveled or

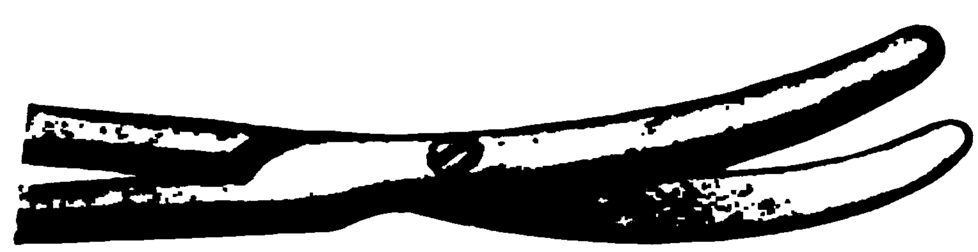


FIG. 37.—Terson's enucleation scissors.

cut away at the side corresponding to the edge. The thick blade holds or pushes the globe forward at the time the optic nerve is severed.

Straight Scissors.—Two pairs of straight scissors are needed. One extra strong pair, with blades 3 1/2 centimeters long and 8 mm. across the base, for canthotomy, cutting mucous grafts from the lip, enlarging cutaneous incisions, etc. One blade should be heavier at the end than the other, and neither must be sharp-pointed. The second straight pair are built on delicate lines—blades 27 mm. long and scant 5 mm. across the base, and with the combined rounded ends 1 mm. wide. These are best for making straight incisions in the conjunctiva and in a number of ways.

Iris Scissors.—It is customary among oculists to have a pair of extremely delicate, curved scissors exclusively for cutting the iris. The smaller pair of strabismus scissors would do in an emergency, though their points are a little too thick for cutting the membrane close to the cornea. The blades of the regulation iris scissors are about 2 1/2 centimeters long, 4 mm. across the base, and taper down to a fine, not keen, point where the thickness of the two superposed ends does not exceed 1/3 of a mm. Such

[1] Annales d'Oculist, Dec., 1905.

scissors are also useful in the excision of minute tumors of the conjunctiva and about the lid margins. They have largely given way to the

De Wecker's Forceps Scissors (Plate VII).—Many of the merits of this valuable instrument are discussed in the chapter on Iridectomy. It is marvelously contrived, yet simplicity itself. The scissors arrangement is peculiar in that the blades are not united by a pivot. The fastenings are high up, one nearly midway of the branches and the other at the top. The lower one is so constructed that, in closing the wings with the fingers, it forces the branches apart. This constitutes the spring that keeps the blades open—or opens them after closure. The blades are about 7 mm. in length and about 1 1/2 mm. wide at the base. The ends of the blades are made both blunt and sharp, or one blunted and the other sharp For my part, I prefer to have them both blunt. The scissors are set at an angle of 125° to the branches, or a reverse angle of 55°. The entire length of the branches, including the button at the top, is a little more than ten centimeters, and their greatest width 8 mm. These are the dimensions given the instrument by De Wecker and by his instrument maker, Matthieu. Common faults of it, as it appears in the shops, are heaviness, too strong a spring, and want of proper coaptation in the blades. The great advantage the forceps scissors possess over ordinary iris scissors is that by the upright position in which the instrument is held while making the excision of the iris, the hand is brought close up to the site of operation, which adds immensely to precision. Besides their legitimate office of cutting the iris, they are also valuable for extending an insufficient corneal section in the operations for cataract.

Other Forceps Scissors.—Any than those of De Wecker are seldom employed; yet there are times, as, for example, when one has to deal with a dense membranous cataract, a closed pupil with aphakia, that defies all other means of establishing an opening, when a tiny species of scissors, suitable for work in the anterior chamber, becomes an absolute necessity Fortunately, these needs are found in the Charrière capsule scissors or the Dowell iris scissors. The first is patterned after the ingenius Desmarres' capsule forceps; the second enjoys a most fitting model all its own.

Its curved and forceps-like branches and its diminutive pivoted blades make it superior to Charrière's as regards manipulation. A fair-sized, not too peripheral, incision is required. This brings us to the

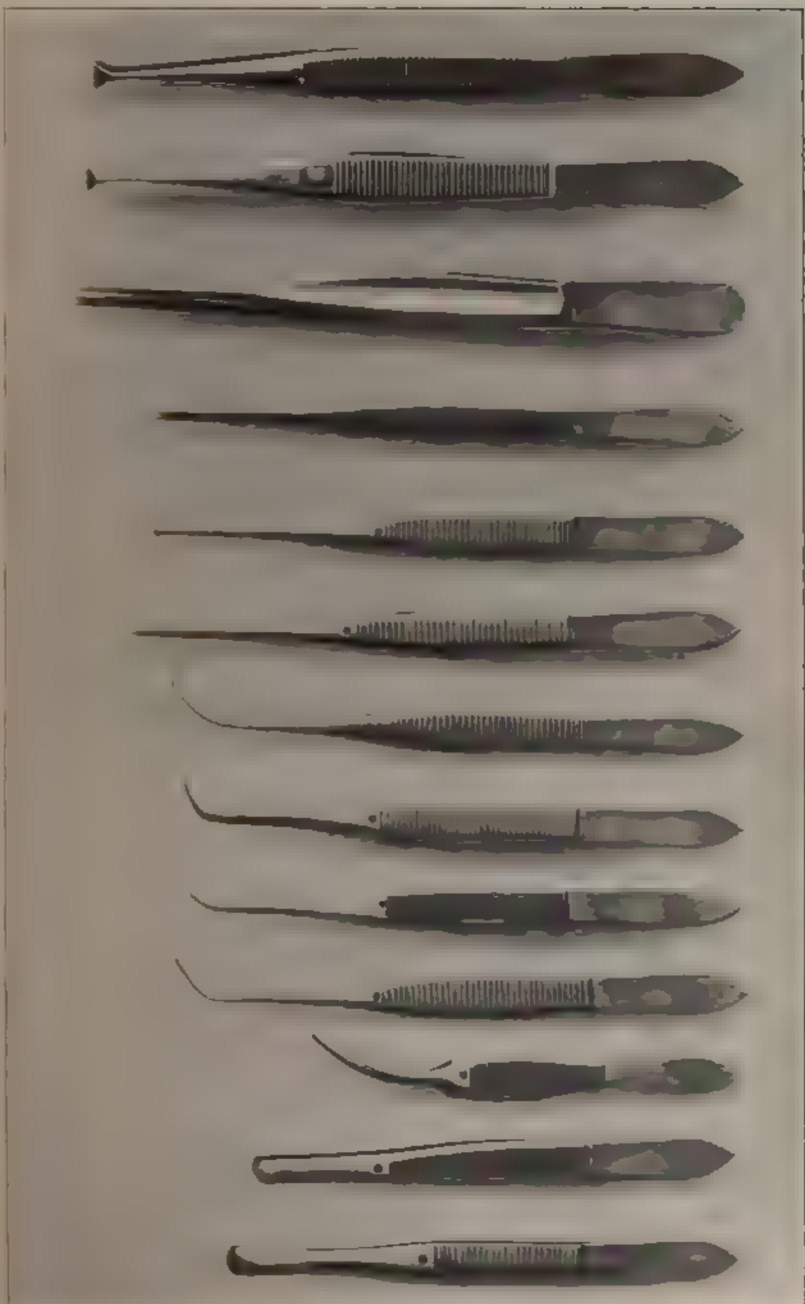
Forceps—This group is composed of many classes, and of all the instruments comprising our selection, the greatest number going under one common name will be representatives of the said classes. As it is with the scissors, the great trend of instrument makers is to manufacture eye-forceps that are too bulky and clumsy, to make their springs too stiff, and to neglect properly tempering the steel, especially in those with the more delicate extremities.

Fixation Forceps (Plate V).—There are various kinds of forceps used in ophthalmic surgery more or less for the purpose of steadying, or fixing, the parts. By way of distinction, therefore, the name is almost wholly restricted to that which is employed to immobilize the globe in operations that involve it or its external muscles. Among other kinds are the rat-tooth, mouse-tooth, advancement, and lid forceps, etc., so, as each of these is well named, we may, with propriety, restrict the term *fixation forceps* as stated. This instrument is made either with or without a catch for locking the jaws. The lockable kind is fast falling into disuse, especially for operations under local anesthesia, in which the globe is opened, because of their startling effect upon the patient in unsnapping the catch. In narcosis this objection does not hold, but it is sometimes impossible to make the thing let go instantly, as, for example, when the virtreous is escaping. The catch is useful at times, however, therefore it is well to have one pair with, and one without it. In all respects save those referring to the locking device, the two instruments are alike. The best and most elegant forceps of all classes, to my notion, are those made in Paris, and the dimensions here given relate to these. The total length of the fixation forceps is 11 centimeters and 3 mm., and the greatest breadth 8 mm. The articulating portion of the jaws is 4 mm. in extent, is provided with sharp, angular teeth that dovetail together, and is slightly concave to fit snugly against the sclera. Those in which the teeth cross each other, so as to project slightly from the jaws where the forceps is closed, are surer to hold. When the teeth are insignificant or worn down, the holding power is not to be depended

DESCRIPTION OF PLATE V.

58. Fixation forceps without lock.
59. Fixation forceps with lock.
60. Rat-tooth forceps.
61. Mouse-tooth forceps.
62. Strabismus forceps.
63. Dressing forceps.
64. Median tooth iris forceps.
65. Förster capsule forceps.
66. Wecker capsule forceps.
67. Knapp capsule forceps.
68. Toilet forceps.
69. Correct cilia forceps.
70. Large cilia forceps.

PLATE V.



58 59 60 61 62 63 64 65 66 67 68 69 70

upon. As to the locking variety, it behooves one to see that the catch works easily and smoothly. In case the hold seems insecure, it can be made firmer by picking up the conjunctiva and tissue beneath in a rather large fold and giving it a twist.

Beard's[1] Fixation Forceps, with the collaboration of Mr. V. Müller, an instrument maker of Chicago, the writer, a few years ago, set about attempting to improve upon the models of this instrument in general use. The chief aim was to produce a fixation forceps that would not necessitate the awkward bend at the wrist, and the placing so much in evidence of the hand that steadies the eye in such operations as extractions and iridectomies. The first product of the effort was an effective, though rather too complicated affair, whose jaws emerged from one end of a tube by pressure

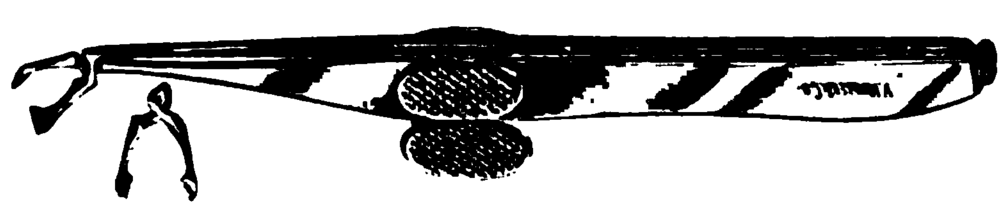


FIG. 38.

of the forefinger upon a knob at the other end. This was abandoned in favor of the model shown in Plate VII and Fig. 38. This is an adaptation of Mathieu's forceps-scissors to the needs in question. The scissors blades are left off, and in their place are the members of the forceps. Instead, however, of moving in the same sense as the scissors, the lower portions of the instrument are given a quarter turn, so that they are set in a position at right angles to that of the scissors. Thus it is not necessary, in fixing the globe to turn the tips of the fingers holding the forceps to such extent that they point toward the operator (Fig. 39), and the forceps hand is got out of the way and out of the light (Fig. 40).

Rat-tooth and Mouse-tooth Forceps.—These two kinds are, as their names would imply, distinguished only by their size—excepting that, rarely, the larger has a couple of extra teeth. The general proportions of the rat- ooth forceps are the same as those of the fixation class. The jaws, however are not extended laterally, but are flush with the extremities of the branches. The teeth are very strong and about 1 mm. in length. There are usually three teeth, so arranged that the one, in the center of one jaw, fits nicely between

[1] See Ophthalmic Record, Feb. 1907, for more desirable text on this forceps.

the two in the other jaw, and, when closed, the extremity of the forceps is smooth, i.e., the teeth do not project. The mouse-tooth forceps is but a smaller type of the same instrument, though it never has more than three teeth. It measures 10 1/2 centimeters in length and 6 mm. where broadest. The larger kind can be very well dispensed with, and its place be taken by the catchless fixation

FIG. 39.

forceps. But the smaller is an absolute necessity. Indeed, rather than invest in one of each kind it would be wel to get two of the mouse tooth. When the mouse-tooth forceps is defective, it is usually as regards the teeth. They lack size and strength or they do not interlock perfectly.

Dressing Forceps. These are exact counterparts of the mouse-

tooth forceps excepting that, instead of teeth, the inner aspect of the jaws presents a series of transverse serrations. A mistake often seen in the make-up of this forceps is that only the terminal tips of the jaws come in apposition without undue pressure upon the branches. There should be contact for two or three mm. without

Fig. 40.

squeezing. This is the most suitable forceps to aid in removing sutures. It also makes a good, all around, toilet-forceps, and is valuable for handling the thread in advancement operations. One is a plenty.

Iris Forceps. There exist a great number of varieties of this instrument, yet there are but two in ordinary use, and they are all

that one needs to procure. These are distinguished only by the disposition of their teeth, and are known as *median*-toothed and *back*-toothed. In general construction, the median-toothed is like the mouse-tooth forceps, the only difference being in the size and shape of the extremities. The terminal thirds of the branches are cut down to about 1/3 the dimensions of the mouse-tooth, and they are made to end in a gentle curve that lies in the same plane as the flat of the branches. This curve extends for one centimeter from the end of the forceps, and it has a radius of about 6 mm. There is considerable diversity in the inclination of the chord of the arc that constitutes the curve, with reference to the axis of the forceps. As it is with the blades of the lance-keratomes, so should it be with this inclination, i.e., it should be the same in the several forceps. A convenient angle for the chord is 45°. That is, the grand angle is 135°. The roughening on the branches that serves to give it a safe hold to the fingers is situated lower down than it is in the mouse-tooth forceps. This is the forceps for all uncomplicated iridectomies. For iridectomies in cases where there is posterior synechia, or for hose in aphakial eyes, etc., the *back-tooth iris forceps* is the more serviceable. Here the teeth, instead of being situated *between* the opposing ends of the branches, arise from the back, or convex, edges of the branch terminals. In the one instance the bite of the teeth is at right angles to the axis of the forceps, and in the other, parallel with it. In one, the teeth are flush with the ends of the blades, in the other flush with the back edges of the blades, and on one side with the end also. It is a serious fault in this variety to have the teeth at a little distance from the end of the branches on *both* sides, for in attempting to seize the iris that membrane might be pushed down, out of reach of the teeth, by the free end of the forceps. The back-tooth forceps often have five teeth—two fitting the interspaces of three. Förster's are thus. Sometimes there are more than five. Again, the teeth are directed somewhat backward and project in interlocking; or they are made bayonet fashion, i.e., are made to occupy a plane still farther back than the posterior edge of the jaws. Such arrangements have very doubtful advantages and some serious drawbacks. The projecting teeth make them difficult to insert without catching, and, with the long, sharp, projecting teeth, there is danger of wounding the lens

if the latter is present. Indeed, these more savage instruments are only fitted for

Capsule Forceps.—For the occasional thickened capsules, and for those of adherent lenses, a forceps is needed for tearing the membrane off and extracting it—*arrachement.* Those that bear the name of De Wecker serve the purpose well. They are something between the ordinary back-tooth forceps and those exaggerated ones just mentioned in that their teeth occupy a very slight offset at he back of the jaws. This forceps can be made to do very well in place of the back- ooth forceps. Like all the small toothed forceps they must be closely watched to see that the teeth are neither broken off nor out of line with their notches.

An important point in the selection of iris and capsule forceps, if not, indeed, as regards that of all the ophthalmic forceps, is to make sure that the springs by which they open are not too stiff. "In order to manipulate an instrument with the greatest delicacy and certainty, said manipulation must, like the simple hold between the fingers, call for the least possible force. In other words, the strength which we must exert to hold our iris forceps shut destroys just that much of the nicety and precision in handling the instrument and of the daintiness of touch. While insisting upon it that the springs be soft, let it not be understood that the branches, or members, themselves should be flexible. On the contrary, they must be firm and rigid. This principle is illustrated by examining certain forceps and noting that the extremities of their jaws open, instead of closing, when their (too weak) branches are pressed upon.

Rotary Iris and Capsule Forceps.—To this class belong those of Liebreich and of Mathieu, and their advantages are explained in the chapter on "Operations Upon the Iris."

Toilet Forceps.—For making the toilet of the eye after iridectomies and extractions the dressing forceps are not well adapted, being too straight and too big. Hence, the small, curved toilet forceps of De Wecker, are recommended. This is nothing more nor less than ordinary iris forceps, deprived of their teeth and supplied, instead, with the fine crosswise roughening similar to the dressing forceps. Like it, too, there should be contact of the jaws for a short distance from the ends of the branches—say for about 1 mm.

Cilia Forceps.—A scientifically wrought cilia forceps is not always to be had. Most of them are bad. Landolt says, "I cannot fancy what evil genius pursues this little instrument. It seems to be fated to bear a form that is neither graceful nor suited to its purpose. Time and again, and unceasingly, cilia forceps are fabricated that have jaws as big as shovels, heavy enough to crack nuts, and, in shape, suggestive of the hoofs of a horse placed base to base" (Plate V, No. 70). It is precisely this horse-foot construction that constitutes the objection most frequently found in cilia forceps. That is to say, the area of the opposing surfaces of the jaws is too great or it reaches too far from the tip. Hence, in attempting to pull out a fine hair, through squeezing together the branches the proximal edge of the broad articulating facet acts as a fulcrum, to pry open the distal parts of the jaws, and the hair is let go. An effective cilia forceps would be about 85 mm. long, 8 mm. wide in the broadest places, and the branches should be of good thickness (Plate V, No. 69). The roughening for the fingers should be carried to within 1.5 cm. of the extremity of the jaws. The latter should not be more than 2 to 2.5 mm. wide, by 1/2 mm. deep, and should have their articulating surfaces elevated 1 mm. above the inner planes of the branches, and be perfect with respect to coaptation. To interpose a peg or pin between the branches in such a way that it will not permit of their being bent inward by too much pressure of the fingers is a good idea. Moderate pressure in epilation gives better results than does excessive.

Advancement Forceps.—To those who feel the need of forceps for clamping and holding the tendon in squint operations, I would recommend Prince's advancement forceps. Their jaws are set at an angle, in the plane of the flat of the branches, consist of one spiked member and one correspondingly perforated one—or, in technical phraseology, of one male and one female member. For the rest, the instrument is identical with the locking fixation forceps. This is a simpler and more effective tendon-clamp than is that of De Wecker.

Trachoma Forceps.—This subject is treated of in the chapter on the "Surgical Treatment of Trachoma."

Lid Forceps and Clamps (Plate VI).—In this class are included not only all the forceps used for holding and fixing the lid, but also

the *lid clamps.* In fact, the two instruments cannot be separated into distinct classes, as one merges into the other. True, there are lid forceps and lid clamps, pure and simple, but more often it is a combination of forceps and clamp. The modern lid forceps spring from " Jäger's T forceps. The original is still in use, as it deserves to be. Of course, it needs a locking attachment. This should be either the sliding catch or the old-fashioned screw, for in these the force of the grip can be regulated. The spring catch does not admit of any adjustment, either as regards grip or thickness of lid. Dujàrdin's T forceps, on the same principle as Jäger's, are too savage, because of their teeth. Lid clamps are usually some modification of that of Desmarres, i.e., the essential features are a plate to go beneath the lid, a ring, whose circumference coincides with the outer border of the plate, and a slide, or a screw, to lock the branches. Knapp and Snellen enlarged the plate and left off that part of the ring corresponding to the free border of the lid. In order to still further enlarge the field for operating within the ring, Warlomont has devised an expansible plate that spreads out like a fan. This is placed, unexpanded, into the upper fornix, when, by turning a screw on the end of the handle, the moveable parts of the plate can be made to flare so as to put the cul-de-sac upon the stretch. The ring coincides with the expanded plate. This is evidently an improvement over the older models when it is a question of the more extended entropion operations, for example, as greater scope is afforded for free incisions. But for smaller operations, like chalazion, etc., the others are just as good, and they are far simpler and easier as to their keeping. For chalazion, Wilder's clamp is handy. (See "Chalazion.") For fixing or steadying the lid and for clamping it to prevent hemorrhage in restoration of the free border, as also in median tarsorrhaphy, and to fix it in electrolysis of the cilia, the lid forceps invented by the writer[1] (Plate VI, No. 79) is an efficient instrument. The branches, being attached at the extremities of the jaws, are out of the way for work on either side of the clamp.

Hemostatic Forceps.—One must have two or three of the lightest pattern—Tate's or Halstead's model. Those with long branches—measuring 9.5 centimeters from the pivot to the extremity

[1] Ophthalmic Record, Jan., 1905.

DESCRIPTION OF PLATE VI

71. Prince advancement forceps.
72. Prince expression forceps.
73. Knapp expression forceps.
74. Noyes expression forceps.
75. Kuhnt expression forceps.
76. Warlamont adjustable lid clamp.
77. Beard lid forceps.
78. Desmarres lid clamp.
79. Wilder chalazion forceps.
80. Hunt chalazion forceps.

PLATE VI.

71 72 73 74 75 76 77 78 79 80

of the rings—are less in the way than the short, or dwarf, kinds, as the latter necessitate placing the hand that holds them close to the seat of operation. The jaws, from pivot to end, should not exceed 2.5 centimeters. The working extremity of the jaws should be 2 mm. wide, and slightly rounded. The branches are best if light and elastic. Those with a series of notches for the catch are convenient, simple, and effective.

Needle Forceps.—Those constructed upon the principles embodied in the still highly approved instrument devised by Sands, of New York, are the favored of all eye surgeons. The circular jaws of the Sands forceps have mostly been discarded for the more desirable duck-bill jaws, and instead of deep grooves for receiving

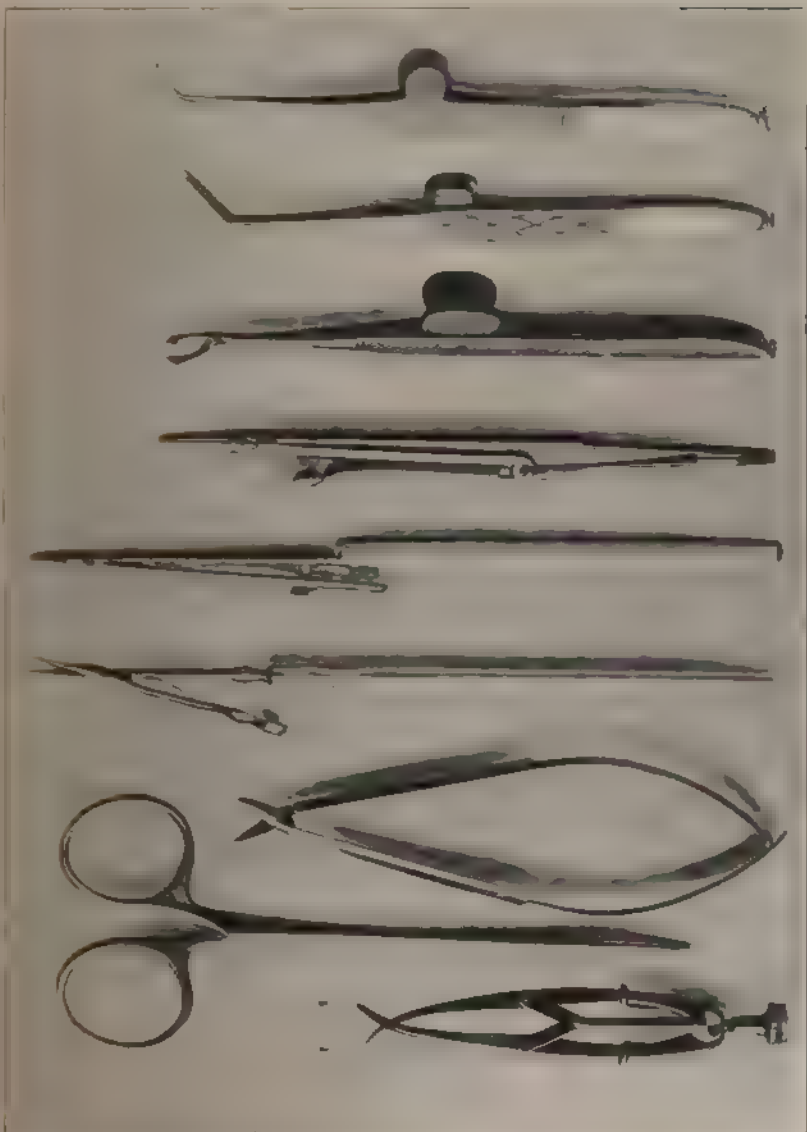
FIG. 41.—Stephenson's needle forceps.

the needle, thus limiting the number of positions in which it can be placed, the surfaces of the jaws are either simply roughened or else they are lined with meta softer than steel, such as copper. It has been urged that, without the grooves, curved needles are more apt to be broken. This is contrary to my observation. Some clever genius—some say Knapp, some De Wecker, some Weiss—thought to turn the free end of the lever toward the handle, whereas, in the Sands model, it is toward the jaws. This arrangement puts the hand that holds the instrument further away, and permits not only greater freedom of movement, but more room for handling the other implements concerned in the operations. The snap catch is to be preferred to the slide, as its manipulation is easier and causes less joggling. It adds to steadiness and leverage if a transverse plate is attached on the side opposite the catch, whereon to rest the forefinger. This plate is lightly guttered to fit the index. The closer the lever, or the catch, to the jaws, the less unsteadiness in letting go of the needle, hence those needle forceps that, like hemostatic forceps, have the catch at the ends of the handles are objectionable. It would really seem more scientific to employ a simple grip forceps, without a catch, whenever practicable, as

DESCRIPTION OF PLATE VII

81. Liebreich rotary iris forceps.
82. De Wecker's forceps scissors.
83. Sand's needle forceps, with duck-bill.
84. Knapp's needle forceps.
85. Noyes iris scissors.
86. Dowel scissors.
87. Todd tendon tucker.
97. Beard fixation forceps.
98. Halsted mosquito hemostatic forceps.

PLATE VII.



81 82 97 83 84 85 86 98 87

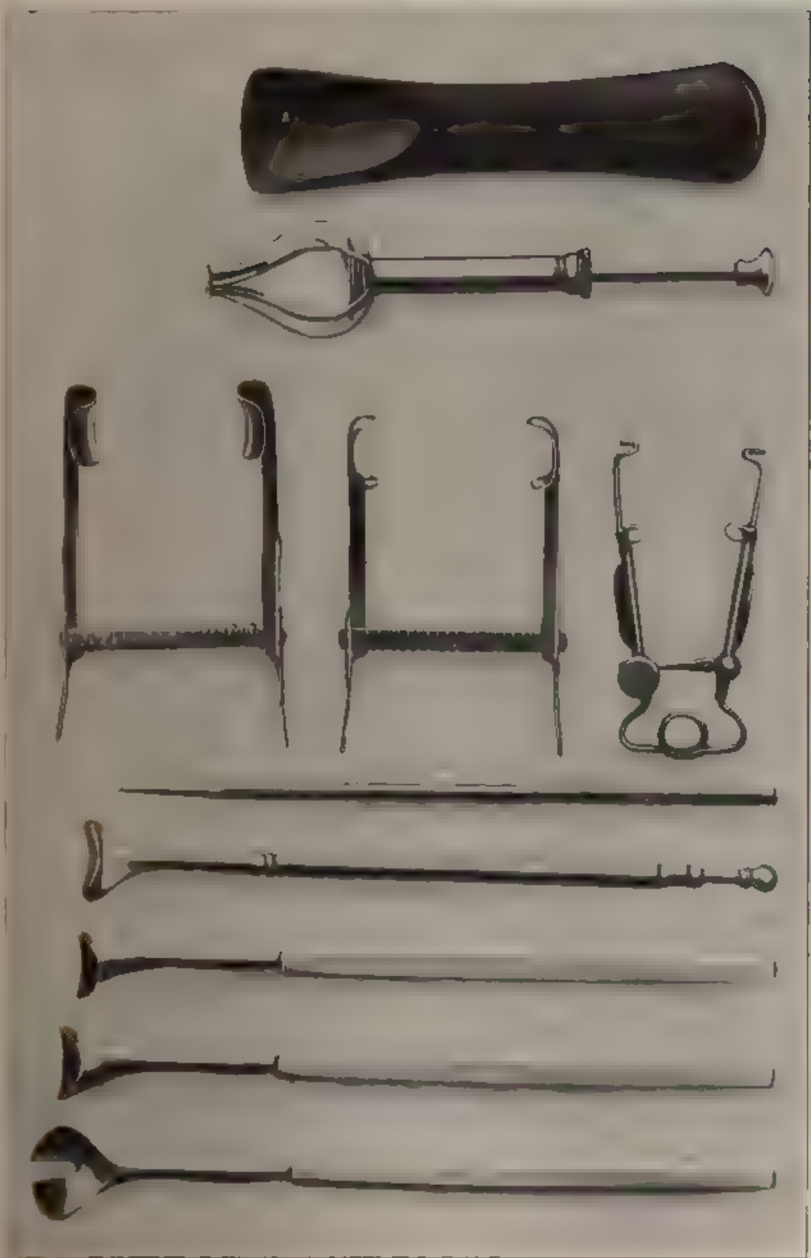
the shock and twisting consequent upon the unlocking are doubtless pernicious. Needle forceps without any form of lock or catch are, however, of doubtful value in any kind of eye surgery. The great objection being that they cannot be so deftly turned about in the hand to assume the various requisite positions without dropping the needle from their grasp. In order to obtain more freedom and ease of handling, one often shifts the hand back to the extremity of the handle. This is a movement of which the catchless forceps will not admit. Moreover, there are certain advantages in using a needle-holder that can be conveniently handed to the operator ready "loaded" by an attendant. A good model of the simpler forceps is shown in Fig. 41.

Blepharostats (Plate VIII), or eye speculums, as they are popularly called, can be quickly disposed of. There is no end to their variety, but, since the appearance of the Mellinger speculum, most of the others have been relegated to the scrap-heap. Practically all of its predecessors had branches, of greater or less length, pivoted at one extremity, carrying lid-holders of divers configuration at the other, and bearing, somewhere between the branches, a more or less complicated locking, or setting, device. As a result of the increasing divergence of the branches in the opening of these blepharostats, the tendency is to pry the lids farthest apart at the free end of the lid holders. Gaupillat dared even put pivoted lid-holders on, to obviate this defect. Then, the catches, ratchets, screws, levers, and things with which the locks were operated—contrivances more cantankerous, especially at critical moments, it were difficult to imagine. Both these faults were done away with at once in the Mellinger instrument. Its branches remain parallel in all stages of separation, and its locking is accomplished in a truly automatic manner. The tighter the lids grip the holders, the more rigid the branches, yet no degree of gripping can interfere with instant closure of the blepharostat. Moreover, the lids can be forced apart by simply pressing upon the ends of the slides. The first of these blepharostats were unnecessarily heavy and big, and the length of the handle or lever portions of the branches was out of proportion to that of the arm portion. Some years ago the writer suggested the lengthening of the handles and the shortening of the arms, thus affording more leverage for the operator's fingers, and less for the

DESCRIPTION OF PLATE VIII.

88. Jaeger lid spatula.
89. Mules repositor.
90. Mellinger-Beard blepharostat solid lid holders.
91. Mellinger-Beard blepharostat fenestrated lid holders
92. Landolt nasally operated eye speculum.
93. Irrigation retractor.
94. Small Desmarres retractor.
95. Desmarres retractor.
96. Terson enucleation shield.
100. Conical dilator.

PLATE VIII.



88 89 90 91 92 100 93 94 95 96

patient's lids; and also the lightening and reducing of the whole mechanism so as to make it more delicate and compact. Two years ago he set about making an improvement in the lid-holders and in the spring, especially designed for cataract operations. One objectionable feature of the majority of lid-holders had been a bar that rested beneath the lid. Many and many an eye has been sacrificed to this, particularly in operations for the extraction of cataract, by its catching in the wound. Another was that the cilia and the ducts opening in the lid border were suffered to pollute the site of operation. The Landolt model has not the bar, but it has the other objection. Only the old, solid lid-holder of Weiss, (or Laurence) was free from both. Yet in all other respects, the Weiss blepharostat is a very clumsy affair, the lid-holders being merely two straight gutters, adapted neither to the curve of the free border nor to the convexity of the globe. Gaullipat and Lang overcame one of these defects by making the bottom of the trough convex, in order to fit the concavity of the lid-margins. In addition to this curve the blepharostat shown in Plate VIII, No. 90, has another at right angles to the first, by which the inner wall of the gutter is made to conform to the convex surface of the globe, and the outer wall to that of the outer surface of the lid. Moreover, the inner wall of the trough is made decidedly lower than the outer, so that its rim will not press up in the fornix, as such pressure tends to produce spasm of the orbicularis and to restrict the rotation of the globe when the patient attempts to look downward, the very direction in which he should look during most operations. The importance of this feature will be appreciated when it is remembered that the conjunctival sacs of many of the cataract subjects are shrunken and the cul-de-sacs shallow. The comfortable way in which the lids are held apart with this form of blepharostat reduces the inclination to squeeze, and the eye can be rolled upward repeatedly without risk of eversion of the corneal flap. The shape of the lid-holders renders them a trifle less easy to put in place than some others, but this is not to be considered in comparison with the *readiness and safety* with which the instrument may be removed. I first thought that it would be needful that one should have a pair of such blepharostats—a right and a left—with a smaller, straighter trough for the lower lid. This was found to be an error. Indeed, the

manner in which the present form depresses that lid gives unusual opportunity for manipulation of the fixation forceps. The whole appliance is made of solid nickel, hence easily kept bright. The arms, being flat, can be easily bent, in the fingers in order to adapt the blepharostat to the varying prominences of eye and temple. This obviates any need of the jointed arms which were also a part of the very ingenious Gaupillat blepharostat of some twenty years ago.

With regard to the spring, it was discovered that its loose ends could become jammed in the slot through which glide the slides, and that so tightly as to make any movement of the arms impossible. Besides, the springs were made of steel, which soon got rusty and out of true. At my suggestion, the Messrs. Müller, who made the modified instrument, put on spiral springs of non-corrosive material, and with the wire at their extremities soldered into a continuous circle. The spring has barely sufficient strength to keep the grooves of the lid-holders applied to the free borders and not strong enough to stretch the eye open too forcibly.

Jager's Lid Spatula.—This well-known and serviceable implement must be in every oculist's outfit.

Lacrimal Probes and Sounds are discussed in the chapter relating to the surgery of the lacrimal apparatus. I believe, however, that Weber's conical sound is not mentioned there. This is

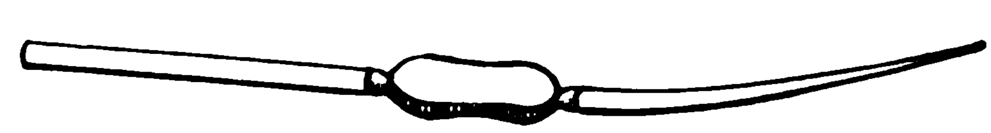


FIG. 42.

a valuable instrument, but rather than have the "double-header" kind, I would choose two distinct instruments, having the top portion merely for a handle (see Fig. 42).

Sewing Needles.—Aside from a very few special kinds, the ophthalmic surgeon habitually employs the various grades of regularly curved needles. The radius of the main extent of the curve of the finest needles is about 1 centimeter. From this they gradually increase up to about 1.7 centimeters, which is about the radius of the coarsest. The length of the needle corresponds to about 1/3 the circumference of a circle. More highly curved, or those including more than 1/3 of the circumference of the circles

they represent, are not, as a rule, desirable. A special needle, for use in advancement operations, is described under "Muscular Advancement." All needles are supposed to have sharp edges as well as sharp points, and their eyes should be smooth and rounding where the thread strain falls, and a large as practicable. The so-called *self-threaders* are all right for most operations, but for those in which it would be disastrous to break the thread, they are not to be trusted, for they cut the strands, thus causing both irregularity and weakness.

A certain number of ordinary probes and cotton carriers, preferably silver, and our selection is complete.

Manipulation of Instruments.—In this connection, Landolt, with characteristic terseness, remarks, "Just as, by the mere act of grasping a foil and putting himself on guard, the classic fencer is distinguished from the pretended swordsman, so is a surgeon of correct training, the moment he touches an instrument, distinguished from the autodidactic operator. The last may succeed, for example, in extracting a cataract without losing the eye—his work, as a whole, may be attended with fairly good results—but no one will deny that, in point of *perfection* of results and *number* of successes, the advantage will always lie on the side of right training."

How obtain this training? Assuredly not standing around operating tables and "looking on!" One would as well try to become an expert billiard player in the same way. A start can be made under the instruction of one fitted to teach. Not necessarily a finished nor a famous operator. Surgery, in this regard, is like music—not all who excel in imparting a knowledge of the art are adepts in its execution, and *vice versa*. Having been grounded in the elemental principles, constant practice is indispensable. In the beginning only upon the fresh eyes of animals fixed in a mask and upon those of the cadaver. Later, upon those of the live human eye, but always, during periods when sufficient opportunity is not afforded for this, keeping up, at least, the work on the animals' eyes. Then, to train the fingers to that suppleness and precision of movement that are of inestimable value to the eye surgeon, all manner of odd moments are utilized. It suffices for this simply to go through with, over and over, the different motions appropriate to the more

important surgical measures, either with the instruments pertaining thereto, with purely make-believe articles, such as pens or pencils, or with imaginative ones, holding nothing. While those movements pertaining to the wrist and forearm are not to be neglected, those of the fingers come first. In addition to nimbleness and guidableness, the fingers must possess delicacy and sensitiveness of touch. These are attained both by systematic exercises, similar to those given the blind in teaching them to read, and in acquiring knowledge of many external things, and by the scrupulous care of the hands, particularly of the skin thereon. The avoidance of needless wetting of the hands with solutions that destroy the epidermis, by wearing suitable gloves when engaged in any work or exercise that would otherwise lead to roughness of the skin, etc. The great advantages to be gained from ambidexterity are too well recognized to be dwelt upon here. It is becoming so universal for ophthalmic surgeons to be ambidextrous that it now looks almost like a confession of inferiority for one to stand at the left side of the patient, for instance, in making a corneal section for cataract of the left eye.

Modes of Grasping Instruments.—A great deal depends upon *degree of pressure* exerted by the fingers upon the object held. Too tight a grip tends to tremor, lack of motility, and general awkwardness; too light a one, to want of precision and to actual escape of the instrument from the fingers. The happy mean, then, would be to grasp light enough to insure the greatest freedom of movement consistent with a secure hold. After this comes the exact *position* of the fingers relative to the part grasped. This varies both as to the character of the instrument and as to the use it is being put to at the moment. First, as to the instruments with handles. Much has been said about the "penholder fashion" of holding eye instruments. This is a poor illustration. A penholder is held steadily by the tip of the thumb, the pulp of the index, and the inner side of the first phalanx of the *medius*. The motion imparted to the pen is mainly that of the forearm. No turning, or rotation of the implement is practiced or required. Obviously, it is quite another matter when it comes to guiding the objects under consideration. The great factors in the manipulation of the handled instruments are the thumb and the *index*. Between these

the handle is grasped, and by them it is rotated—solely, as concerns its long axis, and partly as regards the other axes. To these ends, the two are placed more directly opposite, even in the so-called pen-holder grasp, than they are in writing—many times directly opposite, with their pulps applied—and the medius plays a decidedly secondary part in both holding and guiding (Fig. 43). Its functions are to lightly support the grasp and to give an occasional touch in guidance. Rotations of the handle, on its transverse axes, are accomplished in great measure by turning the entire forearm, though it is surprising to what an extent trained fingers can effect these movements also. The wrist-joint — i. e., whole-hand movement—is called into requisition much less often in ophthalmic than it is in general surgery. Upper-arm movements are to be *limited*, but in no way *restricted.*

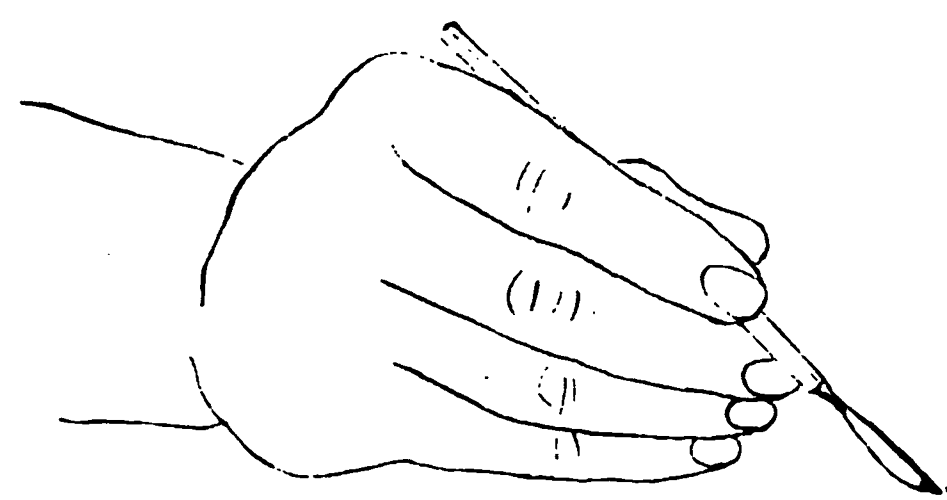


FIG. 43 —Pen-holder

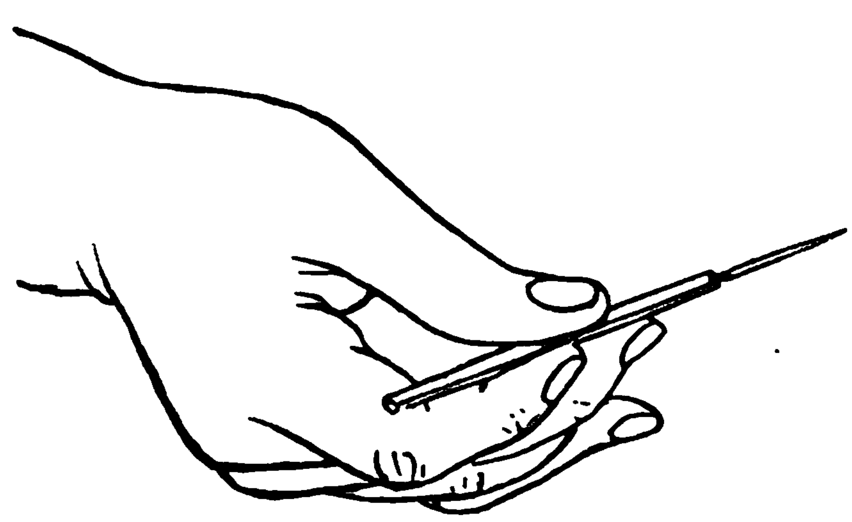


FIG. 44.—In extraction right.

Detailed specification as to the exact manner of holding and directing each of the instruments with handles would, without practical demonstration, be only tedious and confusing. More can be ascertained relative to the grasp by looking at the accompanying illustrations, than by written descriptions (Figs. 44 and 45). Besides, many points in the manipulations, peculiar to individual operations, are given in connection with the technic

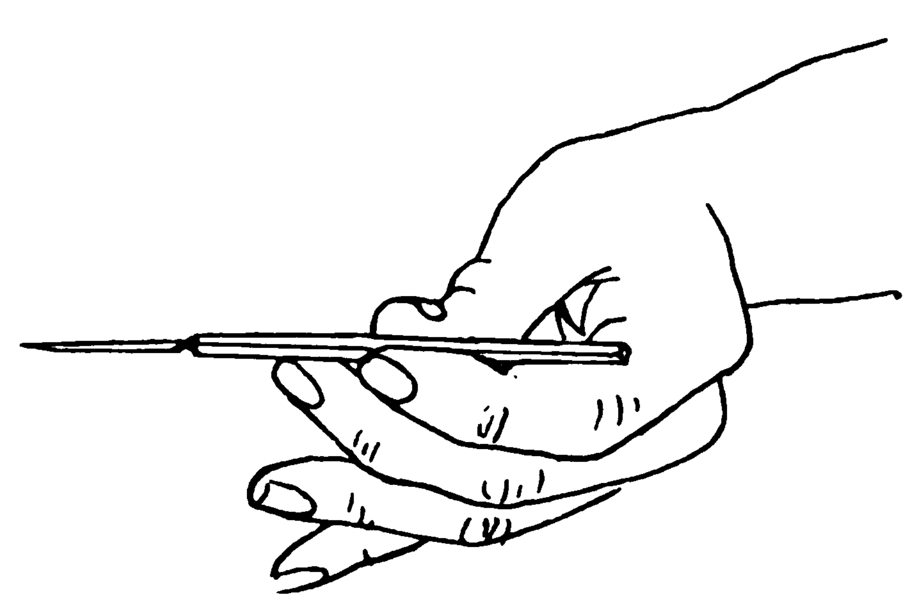


FIG. 45.—In extraction left.

of the procedure as it occurs in the body of this book. For the rest, the reader must look to other sources.

A word, however, as to the "fiddle-bow" method of holding the scalpel, as shown in cut (Fig. 46). The name, while a little more appropriate than that of "penholder" to the grasp in point, only describes it in part. For here the index is usually placed on the upper side of the handle, near the end that carries the blade. The pulps of the second and third fingers are placed side by side about midway of the handle, on one side, and the thumb on the other side, just opposite. The little finger is best left free. This mode is specially conformable to incisions that are made from left to right, as regards the operator, or from right to left when executed with the left hand.

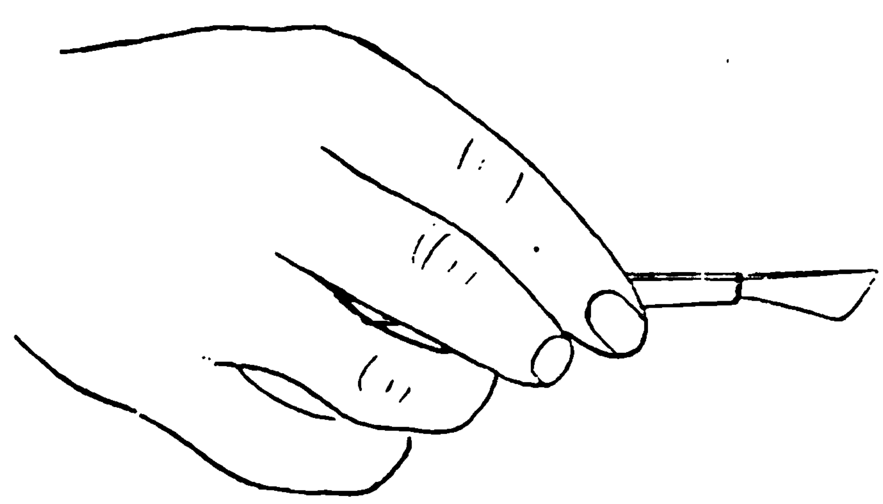


FIG 46.—Fiddle-bow.

The handling of instruments other than those with handles is also treated of further on, where occasion demands. The method of holding the scissors is given elsewhere in this chapter. A word here as to turning them over while in the hand. This is a maneuver that is in frequent requisition with curved scissors. The index is removed from its position with tip resting on the pivot, and dropped back to place it opposite the medius. These two serve then to hold the scissors, while the third finger and thumb are removed from the rings. This is done in the order named, and the third finger, on emerging, gives the ring that it just left a push to turn it in the direction of the thumb; this, in turn, on coming out, pushes the other ring toward the third finger, and the

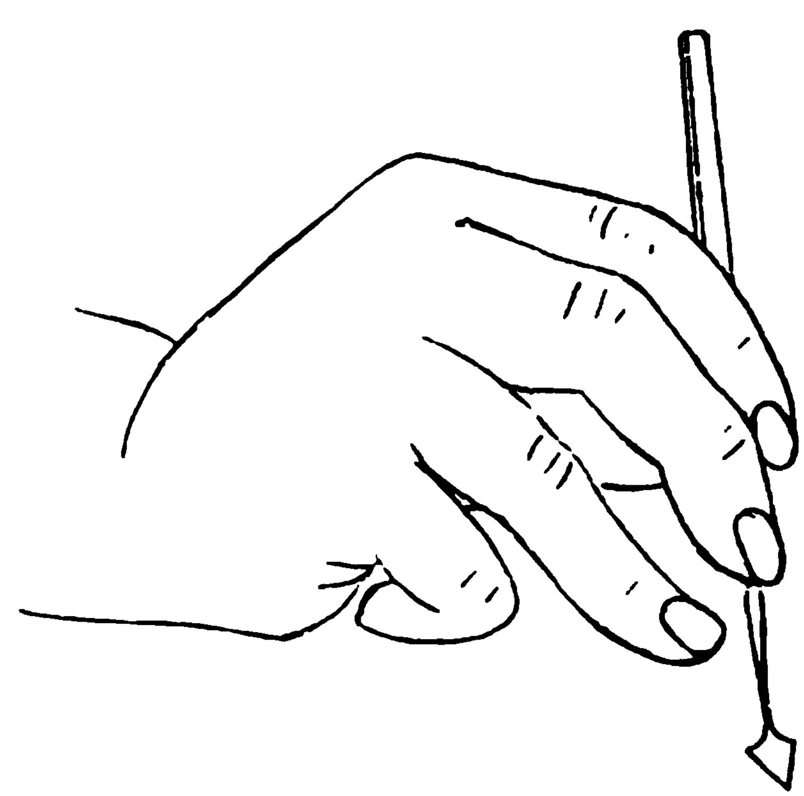


FIG. 47.—Manner of holding keratome.

latter is at once inserted. The thumb is then put into the remaining ring, and the tip of the index put back in its place on the pivot.

The handling of iris and capsule forceps is peculiar in that it rests almost exclusively with the fingers (Fig 48). The pulps of index and medius are placed on one branch, one at either extremity of the roughened area, and the thumb in the middle of the other roughened area. The jaws are advanced into the anterior chamber by a sort of pulling backward on the part of the index and a pushing forward on that of the medius, the thumb being, meanwhile, the pivot, so to speak, on which the instrument turns. In withdrawing the jaws, precisely the reverse occurs. This is one place where the middle finger is called upon for some fine work.

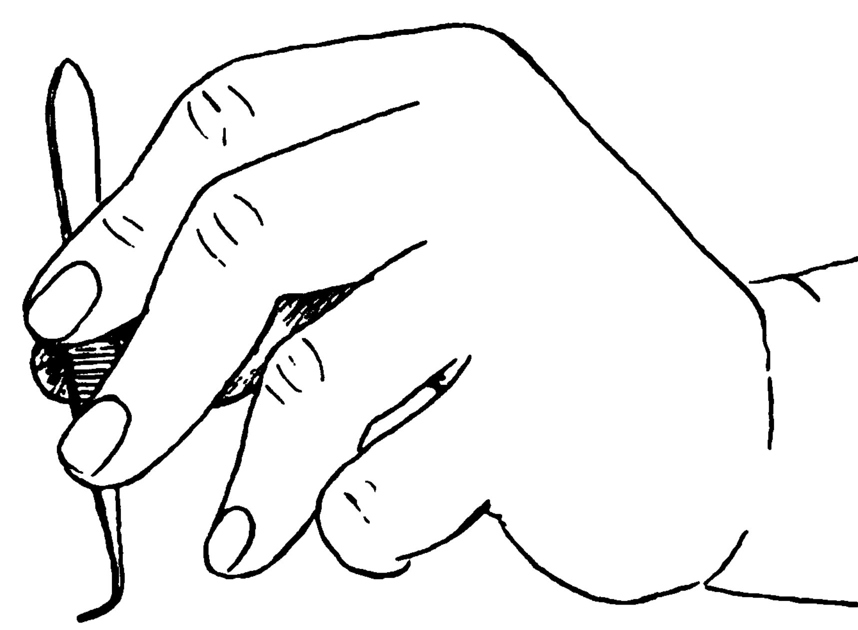


FIG. 48.—Manner of holding iris forceps.

The Care of Instruments.—First as to the receptacles in which they are kept or in which they are carried. A great deal has been said in ridicule and disparagement of the ornate cases, all lined with silk and velvet; covered with morocco, and garnished with the name of the owner in flourishes of gold, the idea being that they were unfit for holding surgical instruments because of one's inability to wash and scrub them; that they should be manufactured only of materials that will bear being *boiled* or immersed in powerful antiseptic solutions. Now, while it is true that those fancy things are somewhat out of harmony with the recognized principles underlying modern surgery, it is, after all, really only a matter of taste or fashion whether one keeps his instruments in boxes bedecked with beautiful stuffs or in those of hard wood and metal unadorned. The box in neither case is of itself antiseptic, nor are the instruments presumed to be ready for use the moment they are taken from the box. If the decorated box will not bear soaking in strong antiseptic liquids, no more will the others. The silk and velvet and the leather can be washed clean with naphta and disinfected with formalin, and that is sufficient for any.

Granting, then, that one is at liberty to choose the material for his instrument cabinets and his instrument boxes, I, for one, would select hard wood. The rarer and finer and harder the wood, the better. A glass shelf or two might be allowed in a cabinet, but there should be no grand array, flauntingly exposed to view in plate-glass show-cases, suggestive of a pathologic museum. For the most part, these should be made up of very shallow drawers, of the same wood as the rest. The location of the drawers is such that none is inconvenient because of being too near, or too far from, the floor. Each drawer has its lock, and, in additions, a device to prevent it from being drawn clear out of the cabinet. In these, however, only the instruments in constant use should be kept. For the handled instruments there would be racks of the corresponding wood or of ebony, and each notch therein should be fitted to, and set aside for some particular instrument, and the different objects should be arranged according to their characters, i.e., the retractors, the spoons, the hooks, the knives, he needles—each group shou d have its allotted space. The scissors and straighter forceps would have their drawers and racks, and be held in their places by delicate springs. The jaws of the forceps would be kept closed by the action of the spring that serves as a rack. All articles, such as blepharostats, odd-shaped forceps, etc., and those not easily damaged, would be loose in the drawers, or in separate compartments therein. For the more particular odd ones, their individual compartments in the drawers should have hinged or sliding covers. There will always be a certain treasured assortment to be guarded apart, to be spared the vicissitudes of ordinary handling—good new, or newly repaired, knives and scissors and the like. And none shall be left in boxes standing about for thoughtless ones to overturn or meddle with. Superposed trays, with racks, etc., are apt to be the cause of more harm than of good to the instruments, by falling, tipping, jamming and crushing. For transporting small selections of instruments for appointed operations, at hospitals or other places, a series of small boxes, each containing from one to four or five articles, is better than putting all or any considerable number into one container. If a box be let fall, or if one is lost, the consequent damage or loss will, in this way, be minimized. The more delicate or more

valuable the instruments, the fewer in a box. Knives are placed in the racks edge downward. An exception is made as regards lace-knives, which are placed pointing to the left. These boxes can be put together in a leather bag or, what is bet er, stuck around in the different pockets of one's clothing. The rounded nickel boxes with racks, and holding springs projecting from the under side o their lids are splendidly adapted to carrying in the pocket. For the non-cutting instruments all that is needed is the plain nickel box, with rounded corners—i.e., without racks or springs. A layer of absorbent cotton is put in first, then the instruments, then enough cotton laid on top of them to prevent rattling about. If forceps are put into such a box, each should have a section of rubber tub ng slipped over its branches to keep its jaws closed. Before boiling, the rubber must be removed, else a tarnished streak will appear at the place it occupied. Also, in boiling, the delicate ends of instruments should be wrapped in, or wound with, absorbent cotton, to protect them from injury. All knives should be clamped in racks before boiling.

To Protect From Rust.—If steel instruments are put away dry they seldom rust. Especially is this true of those that are kept in dry buildings and of those in daily use. Such as are out of present use or are being kept for any reason would better be given a coat of cocoa butter, vaselin, or lard. This refers not only to the plain steel instruments but also to those plated with nickel; for steel in these is often exposed in places. *A propos* of nickel plating, it should cover all steel instruments except the blades of knives, the edges of scissors, and the jaws of forceps. The custom of leaving it off iris forceps and a few others is inexplicable. After using, these instruments are washed first with cool water to remove blood, etc., then immersed in very hot water, and, lastly, wiped with soft linen, then dipped in benzin or gasoline, and allowed to dry spontaneously. This last process has the effect of leaving upon the metal an insensible coating of oil which effectually prevents rust. While it is no more than proper that the water should be sterile in each instance, it is not necessary to use any antiseptic. These are only or use *preparatory* to the operation. It need hardly be explained that the reason the instruments are not put directly into the scalding water after being used is because blood, or other albu-

minoid substances with which they are soiled would be thus coagulated and made difficult to get off.

It has been asserted in many quarters that the process of boiling both corrodes and dulls steel instruments. This is not borne out by experience and observation. If one's experience is that his instruments have suffered in this manner he has probably failed to observe that it was due to something else than the mere boiling. Most often it is because they have remained wet for a time after having been taken out of the sterilizer. Sometimes it is the result of impure water used for the boiling. As an extra precaution against rust, it is well to put a little bicarbonate of soda into the water, 5 to 10 grains to the ounce. Of all the kinds of moisture to which instruments are exposed, there is none more corrosive than that from sweaty hands. Therefore, after handling only, it were better if the article were washed in hot water and dried. Wiping without previous wetting would not suffice to remove the salts deposited on the metal from the evaporated perspiration. Seeing, however, that this will rarely be done, let it be urged, at least, that they be thoroughly wiped.

Our instruments are put through hot water after cleansing with the object of insuring rapid drying, and not that one may dispense with the wiping of them. The drying is as essential as the washing, and the time to do it is while the instruments are fresh and hot from their bath. It is of special importance that attention be given to all angles, joints, etc., to make sure that no moisture remains in them.

Care of Points and Edges.—The worst enemies of these are careless and untrained attendants about hospitals and offices, and conscienceless and unskilled workmen in the repair shops. The first knock them about, rattle them together, and jab them into things, and the second grind them out of all form and substance, and deprive them of their temper or rightful hardness. Hence, the less these persons are intrusted with our sharp instruments, the better off we shall be. Certainly, as concerns the more delicate and responsible articles it were decidedly to the advantage of those most interested, i.e., the patient and the operator, if the surgeon himself took sole charge of their care and maintenance, even to the sharpening of them. He who is not already schooled in such matters

can usually acquire the requisite training without difficulty. If he cannot be an expert, he can at least become enough of a *dab*.

Unless a knife or a needle meets with some accident, as a fall or a jam, whereby the edge or the point is positively damaged, no grinding upon them is ever necessary. They are then never dull in a gross sense. All they need, even after having been repeatedly used, is honing and polishing. These are best accomplished by means of a fine strop and the best of rouge pomade. Pastes containing gritty substances, as, for instance, pumice or emery—no matter how finely these substances are powdered—are ruinous, and ought scrupulously to be avoided. If a point be broken or turned, or if a blade be nicked, the proper remedy is cautious grinding on a whet-stone of good quality, with the liberal use of vaselin or cold water. The great *desiderata* are to obtain the maximum of keenness or of trenchancy with the minimum loss of substance and to preserve the correct model of the working part of the instrument.

Testing.—The most suitable material on which to test the degree of sharpness of eye instruments is known as French trial kid. This means the thinnest and most delicate tanned kid—preferably of an animal that has not gone to the full term of gestation—and not split goatskin nor the still more objectionable shagreen, which is made from horses' hides. The instrument is commonly tested with the kid stretched over a drum. I prefer to dispense with the drum and manipulate the leather with the fingers The point of a knife or a needle, to be right, must pass through the kid without a jog or audible tick, and almost without sensible resistance. Keratomes, bistouries, cataract knives, and knife-needles should have their entire edges tried, from point to heel. In severing the kid they should not emit a distinct sawing or ripping sound. This indicates a too-pronounced serration, which is only appropriate to the larger scalpels and to the grosser instruments generally. A single puncture or incision is sufficient, as repetitions only result in loss of harpness.

To try scissors they are closed down tightly, making a cut in the kid, then removed from it with blades still closed. If the points hang or catch the leather in the least the condition of the instrument is faulty. Either there is dullness at the extremities of the blades

or else there is a tendency to fork. Both are bad, for the reason that the very tips of the blades constitute in the scissors the only parts that actually engage the tissues. Wantonly opening and shutting scissors, when they are not in real use, is highly pernicious, as it spoils their edges, produc'ng roughness and grating. This can be made to disappear, when not too far gone, by passing the edge of the thumb-nail or other smooth object of similar hardness along each blade, pressing *from* the flat, or articulating side, *toward* the bevel.

A BALANCE FOR KNIFE TESTING.

SMITH, PRIESTLY, Birmingham (Ophth. Review, Aug., 1903), has devised a simple instrument to determine by actual measurement the pressure which we have to employ to cut or puncture the leather of the test-drum. It resembles a see-saw in miniature. One arm of the beam carries a small drum covered with the thin white kid (shagreen) sold for this special purpose; the other is marked with a scale indicating grammes, and carries a sliding weight which gives to the drum an upward pressure varying from 0 to 18 grams.

To test the point of a knife the drum is placed in a horizontal plane, the point gently pressed against the leather, and the weight moved until the knife persistently punctures the leather instead of depressing the beam. All punctures should be made in the transverse diameter of the drum so as to be at the same distance from the fulcrum.

To test the edge, the drum is placed on edge, vertically, and the knife, passed through a slit in the leather, is pressed downward without thrusting or sawing. Using a given piece of leather for all, a number of knives may be compared and placed correctly in order of merit. We can measure the effect on a given knife of immersion in boiling water, of antiseptic fluids, or of use, and compare various models of puncturing or cutting instruments.

Good Graefe knives, new or newly sharpened, puncture at a pressure of 1 to 2 grams. They cut at from 10 to 14 grams, and with a tight leather some of them at 8 grams. As a rule, they cut more easily near the point. Cataract needle-knives cut at 14 to 18 grams. Cystotomes, new, punctured at 4 to 8 grams; resharpened, at 10 to 18 grams.

CHAPTER III.

OPERATIONS UPON THE APPENDAGES OF THE EYE.

THE LACRIMAL APPARATUS.

Dilating the Punctum.—Probes or sounds and the canulas of lacrimal syringes up to one millimeter in diameter may be passed through the undivided punctum by first stretching this opening somewhat. The measure usually suffices to reestablish the punctum when superficially closed.

The Most Suitable Instrument is the conical probe or stylet of Landolt (Plate VIII, No. 100), a modification of Bowman's "director." The kinds commonly on sale by the dealers in surgical instruments have cones that are too long, slender, and sharp. Their excessive length and slenderness are objectionable because they necessitate a maximum of entrance into the canal with a minimum of dilatation of the punctum. The point of the excessively long ones might bring up against the lacrimal fossa ere the stretching was sufficient. Their sharpness of point is objectionable for the reason that it is apt to wound the walls of the canal, causing false tracts, etc. The cone, then, should not exceed two centimeters in length, gradually tapering from a diameter of two millimeters at the shank to that of one-third of a millimeter at the point. The latter should be neatly rounded or, better still perhaps, have an olive-shaped bulb whose greatest diameter could be one-third to one-half a millimeter. Every eye surgeon, doubtless, has noticed with what facility a tiny bulbous extremity on knife or probe will enter the punctum. The dilator or stylet should have a handle to itself, i.e., not at one end of a handle that it shares with another instrument at the other end. These double instruments, of which a number have been made, do not conform to correct ideas of modern aseptic surgery.

To Dilate the Punctum, the patient may lie on a table, but it is better that he sit in a low chair. A towel is put over his hair. The operator stands behind the chair for the lower puncta, and offers his chest as a support for the patient's head. Supposing it

is the right lower punctum, the left thumb is placed midway of the lower lid, pressed down tight on the lower rim of the orbit to slightly evert the punctum and put it on the stretch toward the temple to resist the inward pull of the probe. This pressure by the thumb helps also to steady the patient's head. The patient is told to look upward, the probe, anointed with sterile vaselin, is inserted vertically, then immediately turned to the horizontal and pushed along the canaliculus till the dilatation is deemed sufficient and thus held for a few moments. When the progress of the cone becomes a little difficult, slight rocking of it on its long axis will aid its further entrance. If syringing or probing is to follow the dilatation, an assistant stands by, holding the lacrimal probe or syringe, as the case may be. When it is time to withdraw the dilator, this is resigned to the assistant, the operator takes the probe or syringe, places the tip of the canula at the punctum, and, still holding the lower lid down and out and patient looking steadily up, the assistant withdraws the dilator, and before the opening has time to contract, the canula or probe is introduced. Treatment of the lacrimal canal with dilator and syringe will often result in closure of the punctum within a very few hours because of the rawness and fissuring induced about its rim. To prevent this, whenever practicable during the early period of handling a smooth stylet dipped in vaselin should be inserted a little way two or three times a day.

Probing the lacrimal canal is resorted to mainly for exploration and for rendering it patulous throughout. It should be seen to that the tip of the probe is nicely rounded—in no way sharp nor angular. The latter are common faults with small probes.

FIG. 49.

The probes most commonly employed are those devised by Sir Wm. Bowman nearly fifty years ago (Fig. 49). They consist of three double-ended instruments, i.e., six probes, made of silver, each bearing midway a shield to indicate the direction of any bend or curve that may be given to the probe while in use. The shield also bears the figures denoting the sizes. The diameters of those of to-day are graduated by one-half millimeter from one-half up to three millimeters.

There are various other forms of the lacrimal probe, notable among them the series devised and successfully managed by Theobald, of Baltimore. It comprises sixteen instruments graduated by one-fourth millimeters from one-fourth to four millimeters. Most eye specialists do not avor those that exceed four or five millimeters. Whether the upper or the lower route be selected as the better way from punctum to sac would seem to be largely

FIG 50.

a matter of individual choice. Much can be said in favor of either, though the lower canaliculus is favored by the majority and is the one now in question. Bowman's probes are always serviceable, though the bulbous tips go best (Fig. 50).

The writer[1] employs a series of gold sounds that he devised several years ago, represented *actual size* in the accompanying illustration (Fig. 51), and finds them both serviceable and easy of manipulation. Nos. 1 and 2 it was thought best to have made of ten-

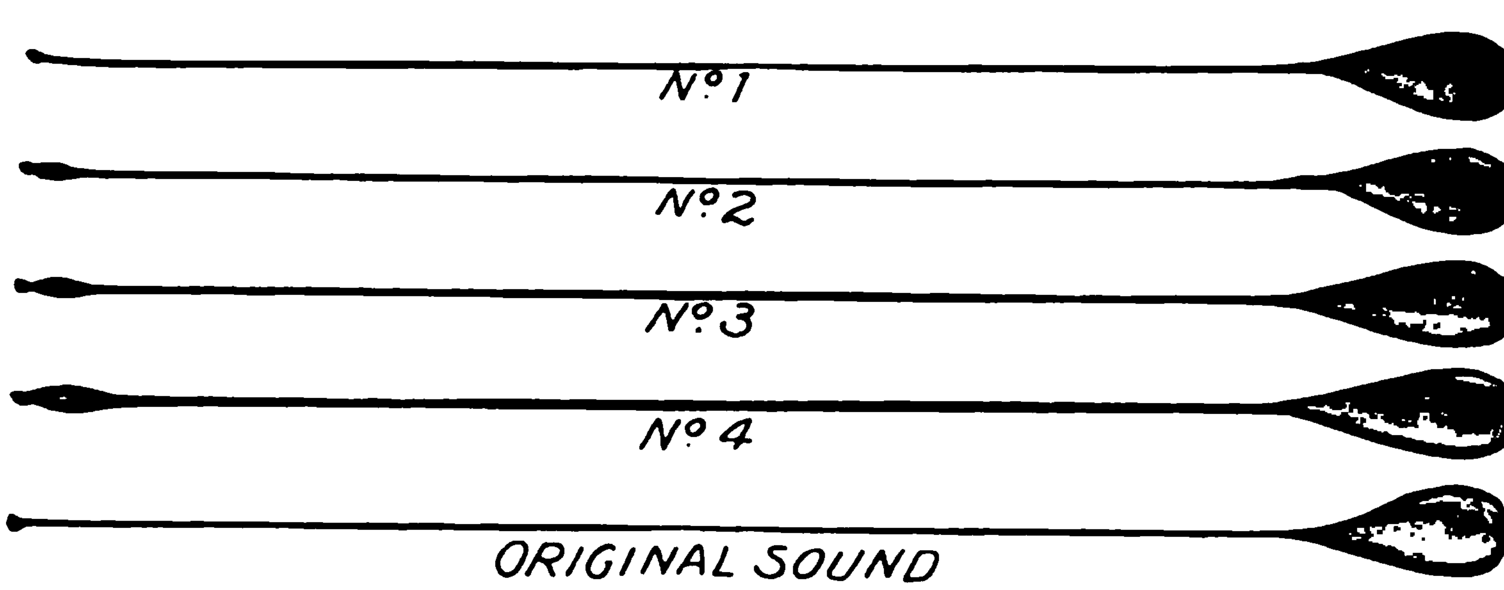


FIG. 51.

carat gold, as this has greater s rength, hardness, and elastic ty than the finer metal, to say nothing of the lesser cost; whereas, Nos. 3 and 4, being of larger size, and destined for other service—namely, only in cases where Bowman's operation has already been performed are made of fourteen-carat gold. The working end of the instrument is spindle-shaped and is surmounted at the tip by a small guiding bulb whose diameter is considerably less than that of

[1] American Journal of Ophthalmology, Oct., 1901.

the spindle. The diameter of the shaft is also much less than that of the spindle, and owing to this fact the friction, instead of being all the way along, is practically confined to the enlarged portion only, yet the effect is that of a probe of the diameter of said enlargement; hence, traumatism and discomfort are both minimized. They are especially useful for systemic treatment, as for example, of stenosis from swollen lining, from cicatricial bands, etc., since they pass both backward and forward through the narrow places with great ease, and can be insinuated cautiously and certainly into such places with the view to local dilatation. Indeed, one of the chief advantages in the employment of these sounds is one's ability, owing to the peculiar form of the instrument, to feel along, as it were, for obstructions, and thus to locate and deal with them by passing the spindle back and forth through them—a procedure not possible with rigid sounds or those that are cylindrical and of uniform or nearly uniform diameter throughout.

In the manufacture of these sounds the strictest attention should be given to minute detail of form. To mention a few points, for instance, the bulb on No. 1 and the entering or guiding bulb on No. 2 should not exceed 3/5 millimeter in diameter, and both should be neatly rounded. Then, where bulb joins spindle and where spindle joins shaft, there should never be abrupt curve, but one part should be made to pass into the other by almost insensible degrees. The size of the spindle ranges from two-thirds of a millimeter in diameter up to two millimeters. The bulbs, from one-third to two-thirds of a millimeter, and the length of spindles from five millimeters for the smaller, to eight millimeters for the larger. The shaft, like the tips, varies from one-third to two-thirds of a millimeter in diameter and is eight centimeters in length. At the distal extremity is a flat shield or heart-shaped plate by which one may always know the direction of the bulb after having bent the shaft in any desired manner. As to the wire for the smaller sounds, it cannot be too springy, but ought not to be of greater thickness than 2/5 of a millimeter; that of No. 1 could well be just short of that. The two smaller sounds are introduced without previous dilatation of the punctum. No. 3 can be used only after dilatation, whereas No. 4 is employed in cases where Bowman's operation has already been performed. The one in

the illustration marked "original sound" was made from the temple wire of an old pair of spectacles, and it was this which, used in an emergency, was the forerunner of this series of sounds. The shield was put on to make it conform to the others, and it is still of great use. Its original spherical extremity was made oblong or olive, thus reducing its lateral diameter.

To pass the probe or sound through the lower canaliculus, the punctum having been dilated or the canaliculus slit, as the case may be, the position of patient, that of the operator and the holding of the lid are the same as for dilating the punctum. The instrument, previously greased with vaselin, is put into the punctum vertically, then instantly depressed to the horizontal and pushed along the canaliculus until the end is solidly against the lacrimal bone. Here it is held snugly while the probe is again approached to the vertical, hugging closely the brow, and pushed down into the nasal or bony portion of the canal. It is well to remember that the direction of this portion of the canal is downward and *inward*, so that while hugging the inner wall of the lacrimal sac or bone with the end of the probe, throughout the elevation of the shaft, the instrument should all the while be pushed down and in. Moreover, the elevation must be stopped short of the perpendicular, else the tip may tend to puncture the tissues outside of the lacrimal fossa of the nasal duct (Fig. 52). It was formerly taught that the bony canals inclined the probes in the opposite direction, and the study of the openings as found in the average skull is in favor of this theory. Actual demonstrations on the living subject prove the contrary, notwithstanding, and there can be no question that the passing of the probe into the nasal duct is facilitated by holding to this view. Whereas he who adheres to the opposite belief and inclines his probe to, or beyond, the median line, on elevating it will find greater difficulty and will be more apt to poke the instrument down into the orbit or somewhere external to the lacrimal fossa.

Where there has been **inflammation of the canal,** there is most apt to be an abnormal constriction just where the canaliculi meet. This may be so tight and solid as to cause the belief that the probe has reached the inner wall of the sac and is ready to descend, which would result in a "false passage." Therefore, when the horizontal

progress of the probe is stopped, if it feels as if it were against a springy cushion or anything yielding, particularly, if on watching the inner commissure of the lids, it moves with the probe it has not entered the sac and the lid should be lightly drawn outward

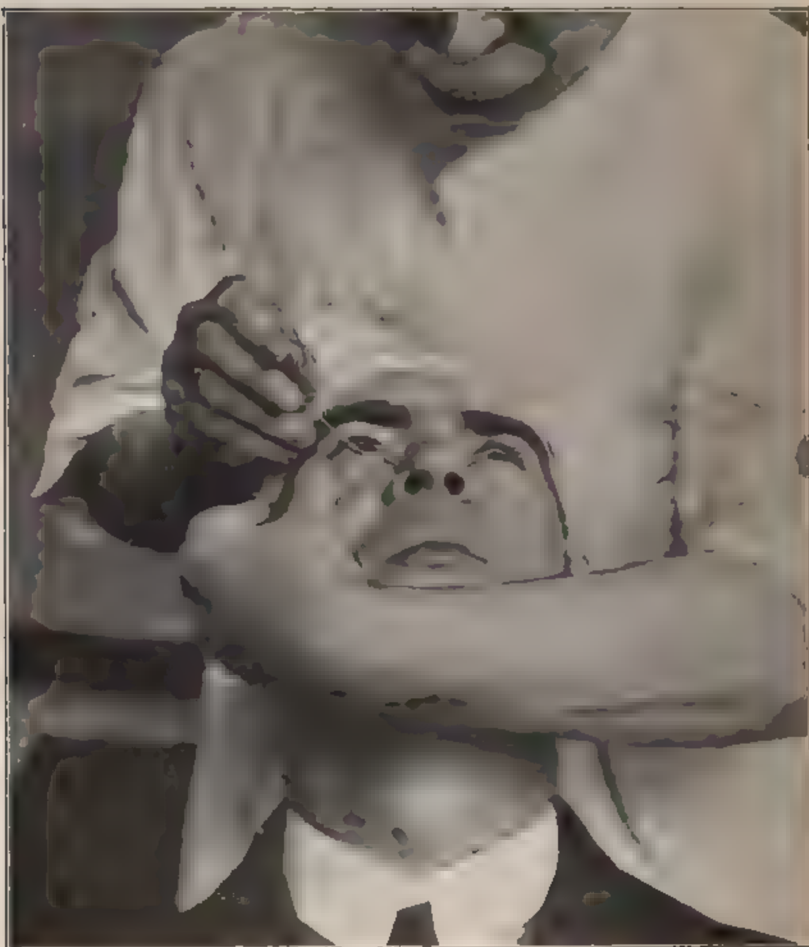


Fig 52.

and the probe forced, with a drilling and oscillating motion, till it brings up solid and firm before elevating. If a reasonable trial of these means is not attended with success, it will be necessary to introduce the smallest probe pointed knife and push it through the

stricture. (For method, see Bowman's operation.) To withdraw the probe, pull up and out until the tip has reached the sac, then depress to the horizontal and finish.

Threading the Lacrimal Canal.—This refers to what is said to be an effective manner of treating persistent dacryocystitis and various forms of stenosis of the canal, reported to the Ophthalmolcgical Society of the Netherlands, meeting of 1907, by Prof. Koster. This surgeon passes a silk thread through the entire lacrimal tract, makes a knot at the upper end, or disposes of it by sticking it to the skin of the lower lid to keep it from entering the canal, coils the lower portion and leaves it in the nose. For the insertion of the thread he employs a series of hollow probes, of different sizes, each having a solid probe that passes easily through it. The latter has an eyelet at its distal extremity. The canaliculus is slit open. The hollow member is passed into the canal until its lower end rests on the floor of the nose, then slightly withdrawn. The thread is put through the eyelet of the solid member, and this is in like manner passed and left with its threaded end touching the floor of the nose. A small blunt hook is used to draw the thread out of the inferior meatus. The thread is now held while both the solid and the hollow probes are pulled out. By partially withdrawing the thread and treating it with remedies, it is made to serve as the medium for their application. The silk is left *in situ* for weeks or even months, if need be. Here one could probably find a sure preventive of the persistent and rapid closure of the punctum referred to, and avoid frequent opening with probe or stylet, but it would be desirable to pass the thread through the undivided punctum. In this case the canula might be dispensed with and a very small probe with an eyelet to carry fine thread—say size 0 or 1, —be used alone.

Syringing the lacrimal canal is indicated for nearly all phases of acute and chronic catarrhal and suppurative diseases to which it is subject. Indeed, eye specialists in general are pretty well agreed that the syringe furnishes the best means for the conservative handling of these affections.

There are several forms of syringe employed for the purpose, mostly some modification of the old Anel model. The illustration (Fig. 53) shows one which my colleague Wilder and I planned and

had made for the staff of the Illinois Charitable Eye and Ear Infirmary, as well as for our private use. The cylinder is of glass with fenestrated metal casting of nickeled brass. The advantages of a cylinder that enables one to see its contents are obvious. The piston-head is packed with asbestos or rubber to admit of boiling, and is made to fit tight or loose by turning the handle. The canulas are made to *shove*, not to *screw* on and are of three forms. One, conic, for forcing melted paraffin or other liquid, as emulsion of plaster of Paris or starch, into the sac to facilitate extirpation. One, large silver canula for use after the canaliculus has been slit, the invention of the late H. O. Tansley, of New York. This has

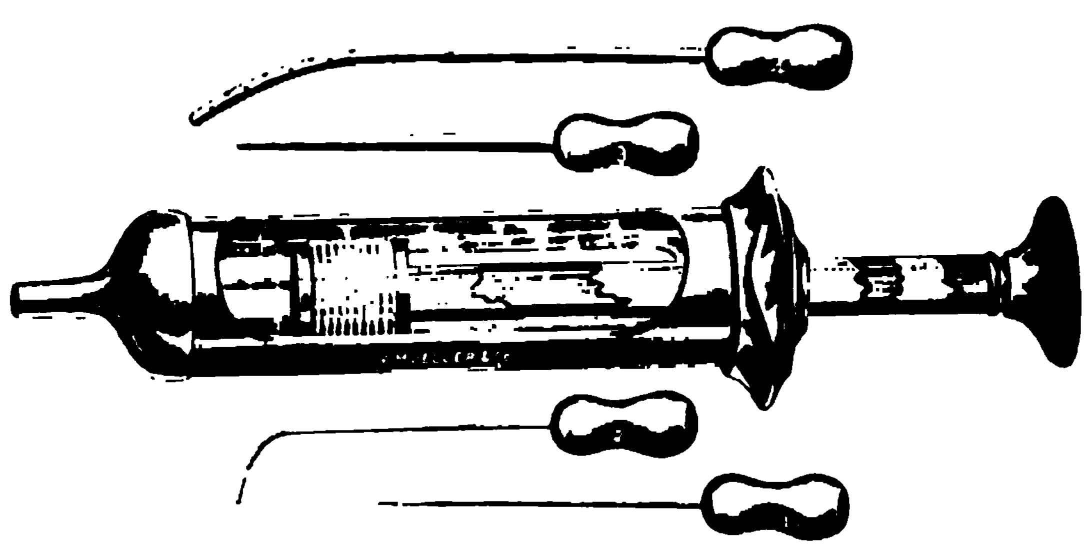


FIG. 53.

a blind tip, but its sides are perforated with a number of tiny openings for a distance of one and a half to two centimeters therefrom. Lastly, two small silver ones for the unopened canaliculus, of equal diameter, but different as to length. The tips of all are made smooth and rounding. The rings of the old model are left off both barrel and piston and, instead, the head is made projecting or flange-like, to afford a finger purchase and of hexagonal or octagonal shape to prevent rolling when laid down, while the handle is in the form of a button. The glass cylinder is fitted at either end with a soft-rubber washer held tightly by screwing down the heads of the metal casing. The Tansley canula is a most valuable adjunct in cases where Bowman's incision has been made, as it performs the office of a probe as well as that of a catheter. By its closed tip the injected liquid is made to wash or bathe the sides or lining of the canal, instead of being shot straight through into the nasal cavity. Having been once introduced, it may be left in position while the syringe is disconnected and refilled as many times as are desirable

Fig. 54.

for thorough irrigation. One must be careful not to push the nozzle of the syringe too forcibly into the hollow cone of the canula for such treatment, as they cannot be readily separated. The Tansley attachment is best made with a light curve and with a shield or facet on the socket to indicate its direction. Every bent canula should have such a guide.

To Syringe the Lacrimal Canal when the Punctum is Intact.—The positions of surgeon and subject are the same as for probing. The first step is dilatation with the conical stylet. The assistant stands ready with the loaded syringe fitted with one of the smallest canulas. The exchange of instruments is made as described under "Dilatation"; the operator lays the barrel of the syringe across the patient's nose so as to point the right-angled curve of the canula perpendicularly, or nearly so, at the punctum. The syringe is held between the first and second fingers of the right hand (for the right eye) placed beneath the ring on the barrel, while the thumb is ready on the piston. It is well to start with such a grasp of the syringe that it will not be necessary to make any change therein, on account of the position of the fingers or the direction of the canula, until it is emptied. As the stylet leaves the punctum, the tip of the canule is slid in, at the same time the whole instrument is elevated, watching that the point does not slip out and holding the lid slightly everted and stretched toward the temple throughout (Fig. 54). Now the patient is made to lean slightly forward, to prevent the injection from running into the throat, and the piston is pressed slowly and steadily down (Fig. 55). If there is a feeling of undue resistance to the descent of the piston, either there is stenosis of the canal or the opening of the canula is engaged in a fold of the lining membrane. It is unwise, even dangerous, then to force matters, as to do so one risks the rupture of the canal wall and driving the liquid, together with infective secretions, into the surrounding tissues and exciting suppurative cellulitis, with all its dire consequences. In this event it is best slightly to withdraw the tip and see that the guide is right before proceeding.

Lacrimal Stenosis of Infants.—It is not uncommon to find epiphora and mucocele in the newly-born and in older infants. The obstruction is usually in the nasal duct itself or at its outlet into the lower meatus. Fortunately, these cases yield much more readily

FIG. 55.

to treatment than do similar affections in older subjects, but the remedial measures should be instituted as early as possible. Often the closure is merely epithelial, and a single passing of the olive-tipped gold sound, described on page 125, will suffice to effect a cure. It is necessary, of course, to pass the sound all the way down till it enters the nasal cavity. This can be accomplished in most instances under local anesthesia, after first dilating the punctum and holding the child's head between one's knees in the regulation manner. Sometimes a few syringings with a mild antiseptic solution will be needed after once the sound is passed.

Bowman's Operation; Incision or Slitting up of the Canaliculus.—The objects sought in this procedure are the evacuation of an abscess of the lacrimal sac that threatens to break externally, the relief of congenital atresia or stenosis from traumatism or inflammatory processes, foreign bodies, such as short hairs, fragments of the beard of grain, and the so-called dacryoliths, or "tear-stones," in the canaliculi, and rarely, the dislodgment of a foreign body that has entered the lower orifice of the nasal duct; to make practicable the employment of the larger probes and of thorough catheterism and for curettage of the sac. Yet other indications are sometimes found, such as eversion of the inferior punctum and new growths.

There are three good reasons why an abscess of the lacrimal sac should not be permitted to rupture through the overlying integument—the obliterating adhesion, the ugly scar, and the hazard of a fistula.

The operation is not made so often as it formerly was, for the reason that the use of the syringe for treatment of ordinary dacryocystitis has largely supplanted the method of systematic and progressive probing that was once so poular. But a single instrument is required, viz., some one of the various modifications of the Weber canaliculus knife. Agnew's (Plate I) is the one preferred by the writer. Its probe point has not the long, slender, easily broken neck of the Weber model. The edge of its blade is slightly convex, which gives better cutting power than if it were straight, and it has a long shank of tough, malleable iron that can be bent to meet the exigencies of an overhanging brow.

Cocain or any local anesthetic is of little value for the opera-

tion unless previously injected deep into the canal, and it hardly justifies the use of general anesthesia. Previous dilatation of the punctum is unnecessary and only adds to the patient's discomfort.

The operation upon the lower canaliculus, the one usually chosen, is performed with patient and operator in positions described for passing a lacrimal probe, and the method is much the same. Given the right, lower canaliculus to incise, for instance, the napkin-covered head of the patient is pulled back and pressed against the operator's chest. The contents of the sac are expressed when possible. The knife is held in the right hand. The left thumb is laid heavily on the right cheek or malar bone, for the three-fold purpose of slightly everting the lower lid, stretching it tightly toward the temple, and fixing the patient's head. An assistant holds the patient's hands and he is requested to look upward during the entire operation. The knife is inserted vertically at the punctum, then lowered to the horizontal, with the edge looking upward and backward. Having proceeded thus far, it is good practice to pause for an instant, see that the position of the blade is just right, take a firm hold upon the handle, bear hard outward on the lid, to make taught the canaliculus, push the knife straight inward until the point stops against the inner wall of the sac, then, while holding it there, bring up the handle, hugging the brow, through an arc of ninety degrees or more, owing to the length of the cut. The plane of the incision, instead of being vertical, is inclined toward the operator. The extent of the incision must be regulated by the peculiarities of the case or the end to be attained. If this be to admit of the use of somewhat larger probes or canulæ than can be readily passed through the normal punctum (*à la de Wecker*) the length of the cut need not exceed three or four millimeters; in other words, an enlargement of the punctum. If a greater opening is desired, the incision may extend to the caruncle. According to v. Arlt, this means about three-fifths of the length of the canaliculus, or it may reach the common duct. In no case, unless for phlegmon of that cavity, is it advisable to extend a free incision into the sac for fear of permanently disabling the internal canthal ligament. If it is desired to pass the knife through the whole length of the lacrimal canal, as the handle nears the vertical the edge of the blade is turned slightly

toward the front and pushed down into the bony portion, as per the directions just given for probing. The knife is brought out and the operation is finished.

As the *tendo oculi* lies in front of the lacrimal gland, it is quite practicable to pass the blade through the sac and nasal duct, in order to divide strictures without seriously, or at all, wounding it, provided the edge is not turned too much forward. In the horizontal progress of the knife through the canaliculus, the anatomy of the parts must be borne in mind, i.e., that the anterior half of the lacrimal fossa belongs to the superior maxilla and is thick and firm, while the posterior half belongs to the thin, yielding lacrimal bone. Hence, if the blade were thrust inward with great force, unless it were directed toward the anterior half of the fossa, it could perforate the bone and enter the nasal cavity.

Stilling's practice of multiple division of strictures of the deeper portions of the canal, for which he designed the knife that bears his name, has been supplanted by systematic and graduated probing. Stricturotomy, as a prelude to forced dilatation of both the membranous and the bony portions of the lacrimal canal, however, is still extensively practiced.

The correct location for the slit is in the posterior superior wall of the canaliculus, hence the necessity for directing the knife with edge slightly backward. Were it along the top or superior wall, it would be unsightly and, worse still, the function of this part of the canal would be destroyed. Even when placed in the most favorable position possible, be it long or short, this incision greatly interferes with the drainage of the conjunctival sac. The suction of the lacrimal sac, caused by the alternate contraction and relaxation of the orbicularis and Horner's muscle, through nictitation, is spoiled by the slit, and this alone is a frequent cause of epiphora. The fact that gravity puts the burden of draining of the conjunctival sac mainly upon the lower canaliculus is a strong argument in favor of slitting the upper one and preserving the lower whenever practicable.

Should the surgeon prefer to wield the knife with the right hand for both eyes and the left canaliculus is to be divided, an assistant stands behind the patient to hold the head, and the operator in front. Otherwise it is behind for the right eye and in front for

the left. The rest of the method is the same as for the right eye, save, of course, that the inclination of the cut is *away* from the operator. In making the operation upon either of the upper canaliculi, as also in dilating and probing them, the surgeon's position, be he ambidextrous or not, is in front of the patient, for both eyes. It goes without saying that the inclination of the blade or the position of the slit is here backward and downward.

Bandaging is not required after slitting of the canaliculus. The subsequent care of the case comprises merely bathing with very hot water or antiseptic washes and the appropriate use of sound or syringe.

Removal of a triangular section of the posterior wall of the lower canaliculus, as first practised by Critchett, of London, for eversion of the punctum, with epiphora, seems to have fallen into disuse. This consisted, first, in slitting up the canaliculus as far as the caruncle, in the usual way. Second, a vertical snip with scissors, extending down two or three millimeters from the punctum, on the inner aspect of the lid. Third, the joining of this with the inner end of the first incision, or the resection of the triangle thus formed. The idea was that the secretions of the eye would thus be provided with an open drain. In effect, it proved to be a delusion, as lacrimal drainage is not accomplished through gravity. Moreover, such a piling up of conjunctival growth took place about the site of the operation as to effectually block any sort of outflow. Arlt produced a form of epicanthus to relieve epiphora in cases of eversion of punctum where the orbicularis was paretic.

In closing this subject, there is one injunction the observance of which cannot be too strongly insisted upon, viz., *as a rule, avoid the use of the syringe immediately after that of the probe or knife.* This is to prevent the unpleasant or serious results of forcing the injected liquid into the cellular tissue. This rule may be departed from in cases that are familiar because of a number of previous probings where the passing of the instrument has been such as to insure freedom from traumatism, but the syringing should be done very cautiously. When probe and syringe are both to be employed in a given case, if practicable, the probe should follow the syringe. If not, it were better to let at least twenty-four hours elapse between the two acts.

Incisions of the anterior exterior wall of the lacrimal sac have been made in cases of dacryocystoblenorrhea, for curetment, as when that portion of the tractus is filled with granulations, to give access to the cautery for its obliteration, and for the evacuation of pus in phlegmonous inflammation. Opening of the anterior wall of the sac is done after the following manner: for the right side an assistant holds the patient's head, as in slitting the upper canaliculus. The operator stands in front. The third finger of the left hand is placed on the skin at the outer commissure of the lids and the palpebral fissure is stretched outward, while, with the index, the tendo oculi is located. A sharp bistoury or Beer's knife is held penholder fashion in the right hand, edge downward. The point is placed just beneath the middle of the inner canthal ligament, with the handle leaning slightly toward the temple. The blade is then pushed back, in, and slightly down, until the point touches the bone at the posterior wall of the sac. The knife is now withdrawn, extending the outer wound slightly downward and outward, taking care not to cut the posterior wall of the sac. The incision may be extended to any desired length, by means of a blunt, curved bistoury, blunt scissors or even a Weber canaliculus knife. For upward lengthening, scissors are preferable, the outer blade being placed beneath the tendo oculi and the inner one, in the sac. To get at the interior of the sac, the wound is held open by retractors, the Müller Speculum, or simple strabismus hooks.

There is apt to be considerable *hemorrhage*, so much, in fact, that where the sac is to be obliterated by the cautery, many operators have chosen to make the operation in two sittings. At the first the opening is made, the cavity packed with gauze, dressing applied and left thus for twenty-four hours. At the second, the cautery. In this way the walls of the sac are dry and in the best possible condition for the finishing process. One may choose between the thermic cautery—as the galvano or Paquelin—and the chemic, as the nitrate of silver or mitigated stick.

Relatively few modern surgeons, however, have recourse to the incision of the anterior exterior wall of the lacrimal sac, preferring extirpation for the first two conditions and the slitting of the canaliculus for the third. This last demands a complete section from punctum to sac or, at least, to the common duct and, in addition,

the subsidiary passage of the knife through the nasal duct, as already described. This is followed by expression of the pus by way of canaliculus or nose. Agnew, of New York, preferred the canaliculus or conjunctival incision to the external or cutaneous one, even to get at the sac, for its obliteration. Others, as A. Tersen[1] for example, for curettage of the sac, first slit the upper canaliculus and then made use of his slender, curved, fenestrated curet (Fig. 56). Many and valid objections to this sort of treatment at once present themselves.

FIG. 56.

The immediate **after-treatment** consists in frequent bathing with hot water. The water is previously boiled and is applied as hot as can be tolerated by the skin by means of pieces of gauze or wads of absorbent cotton. The patient sits erect and holds beneath his chin a bowl, containing the water, which he dabs on continuously for only a few minutes at a time. There can be no objection to making the liquid into a mild antiseptic solution. After twenty-four to thirty-six hours, daily or twice-daily syringing is begun. For this the Tansley blind-ended canula and a twenty-five to fifty per cent. solution of argyrol are most commendable.

Sealing of the puncta, by touching them with the electric cautery, in cases characterized by discharge from the lacrimal canal as a preliminary to such operations as extraction and iridectomy is sometimes done. After the danger of infection has passed, if the openings are not re-established by sloughing out of the eschar, dilatations with the stylet of Landolt may be instituted. Haab once advised, for the above purpose, inserting a slender electrode into the canaliculi for a distance of five or six millimeters and searing the mucous membrane. Rather a drastic step unless attended with extirpation of the sac, in which event it would serve to make the operation complete.

Ligation of both canaliculi, first proposed by Quackenboss and later by Buller,[2] of Montreal, or of the common duct, as practised

[1] Bull. et Mém. Soc. franc. d'opht., 1893.
[2] Montreal Med. Jour., Mar., 1902.

by the writer, preparatory to operations that necessitate opening of the eyeball is, perhaps, next to the radical procedure of absolute removal of the sac and the fiery obliteration of the canaliculi, the best means of preventing infection from the lacrimal canal. Some operators advise tying of each canaliculus separately, but a single ligature applied to both is better. It is advisable, for example, when extraction is to be made and there exists a state of the tear passage that would endanger the result and which, from lack of time, the patient's consent, or other cause, it would be impracticable to remove. The time for the operation is the moment preceding the extraction, and it is performed in the following manner: the contents of the sac and canaliculi are thoroughly expressed. The canal may be syringed with a mild antiseptic wash. Wood, of Chicago, mentions having previously injected a solution of argyrol, letting remain what would. Two No. 1 Bowman probes are passed into the sac—one through the upper, the other through the lower canaliculus—and held there by an assistant, as guides. They are held somewhat apart, so as to mark the outermost bounds of the canal above and below. A half-curved needle of small dimensions, armed with No. 2 or 3 silk thread is passed in just below the lower probe, and close to the inner canthus, deep enough to clear the union of the canaliculi at the back, and out just above the upper probe, and securely tied. The fibres of the tarsal ligament are necessarily included, and so much the better, as they assist in the compression of the canal. Braided silk thread, boiled in paraffin, makes a more suitable ligature than cat- or silkworm gut, as it is not so harsh and irritating to the skin and does not work loose. It is best not to leave it double, i.e., both strands in unless it is doubled and twisted after having been put through the eye of the needle. The ligature may be removed in four or five days or after sufficient healing of the corneal section. If there is any resulting stenosis of the canal, which is not likely, it can be relieved afterward by dilating the punctum and passing a small, olive-tipped probe.

Electrolysis of the Nasal Duct.—We all have cases of epiphora in which the chief or sole obstruction to drainage is an obstinate stenosis of the bony portion of the canal. Usually, by applying great force, a small probe will pass into the nose, but each time it is almost like making an opening through bony tissue. Stricturotomy

is useless or worse. Here is where electrolysis finds an application. Indeed, we have here a form of operative treatment that will often enable us to relieve obstinate epiphora, and in a surprisingly short time, when nothing else would be of any avail. The toughest strictures seem to melt like wax before the electrically charged sound. For a description of the method and the instrument, I here give a translation from Baudry.[1]

"**Preliminary Dilatation of the Lower Punctum with the Conical Stylet.**—An antiseptic injection is useful to disinfect the field of operation. A convenient supply of electricity is necessary. The electrolytic sound of Lagrange (Fig. 57), No. 1 or 2, is passed into the nasal canal. The upper part of this sound is covered with a

FIG. 57.

casing of non-conducting material, to protect the canaliculus and sac, while the lower portion, uninsulated for a distance of two centimeters, is in contact with the nasal canal. The sound is connected with the negative pole of a battery furnished with the galvanometer *aperiodique* (of Chardin) or any practical one, the positive electrode being inserted, wrapped in a wad of cotton, saturated with salt solution, in the inferior meatus of the nose, and held immovable. The current is regulated by a rheostat (*Bergonie's is mentioned*). The current passes slowly and steadily from noughts up to 5 milliamperes, remains at this for three to five minutes, then returns again by insensible degrees to noughts.

These sittings, which are not at all painful, are repeated two, three, or four times, according to the case. As soon as the sound is removed, anther antiseptic injection is made."

Extirpation of the Lacrimal Sac.—This is a comparatively recent surgical measure. True, nearly two hundred years ago Planter tried an excision of the sac combined with an attempt to establish a permanent fistula connecting the conjunctival sac

[1] "Technique Operatoire," 1902.

with the nasal cavity, a form of operation that has been recently revived. Little was done in the way of actual removal of the sac, even following Berlin's important paper on the subject at the Heidelberg Congress of 1868, till within the past 25 years. During this period the procedure has gained advocates in a sort of arithmetical progression. There are two routes by which the sac is got at, one by way of the conjunctiva, or the *mucous*, the other by way of the skin, or the *cutaneous*. In the last decade the first has practically given way to the second.

Mucous Route.—Probably a fair representative of this class is the method of *Van Hoffmann*, contributed to the Heidelberg Congress of 1896. The first step consists in slitting up, after Bowman, of both canaliculi, which are then carefully dissected out their entire length, or as far as their common duct. The loosened canaliculi are grasped by broad-jawed forceps and drawn forward, while the incisions made in slitting them are joined by separating skin from conjunctiva around the inner canthus. This makes an opening from punctum to punctum, or one about 12 mm. long. Through this one works carefully inward, between canthal ligament in front and Horner's muscle behind, to expose the body of the sac. Having freed this front and back, it is pulled downward and the dome is dissected around. The whole is then pulled out at the wound, while, with blunt dissection, the sac is loosened from its bony bed. Lastly, when only the nasal portion remains fast, this is severed with small blunt-pointed scissors, as low down as possible, strong traction being meantime made upon the sac. The only points claimed in favor of the mucous route are freedom from excessive bleeding, and absence of visible scar. When one considers how little these figure in the most approved cutaneous route, and puts this against the difficulties and inconveniences of the mucous route, the advantages are mainly on the side of the former.

Cutaneous Route.—The form of extirpation here alluded to is that first done by von Graefe, in which the sac is removed without intentional incision of its walls, except at the entrances of the common and the nasal ducts, and is, by the writer at least, preferable to that form by which the anterior wall is opened before dissecting out is begun. Seeing that, in order to be most complete and successful, not only the sac, but also the canaliculi and the

lining of the nasal duct should be removed, the operation would better be called "extirpation of the lacrimal canal."

There is considerable diversity of opinion among ophthalmic surgeons both as to the indications for this operation and as to its gravity. The elder Knapp,[1] for instance, considers it too radical a measure to be resorted to unless other modes of treatment have failed. Among these he even numbers the repeated openings of the anterior wall and thorough cauterization—extending over weeks and months—because they are less terrible to the patient and freer from the dangers of suppuration and orbital cellulitis. Whereas, the younger Knapp[2] considers the operation much less formidable and resorts to it often, as in chronic suppuration of the canal that does not yield readily to antiseptic treatment in recurrent abscess, in dilatation of the sac, whether the contents can be expressed or not, and in lacrimal fistula. The operation is undoubtedly growing in popularity, and the indications for making it are broadening more and more. It may be confidently asserted that it affords the quickest, surest and most satisfactory means of curing most of the really bad chronic cases.

Indications.—Among these may be classed all those troublesome affections of the lacrimal passage in which more conservative methods either cannot or may not be effectively carried out, such as

1. Chronic dacryocystitis with mucocele and excessive distention of the sac.

2. Chronic suppuration of the canal with recurrent, phlegmonous inflammation, or caries of neighboring bony structures, or fungosities, and with or without fistula.

3. Incurable obliteration of some portion, as of the nasal duct, through disease or traumatism, with troublesome epiphora.

When the status, as per either of the first two classifications is present, some form of quick riddance, either by obliteration or extirpation, becomes imperative under the following conditions, viz.: (1) If an operation that necessitates the cutting into the globe, wounding of the cornea, or opening of Tenon's capsule is demanded for the eye which is involved, as, for examples, extraction, pterygium, strabismus and enucleation. (2) If there exists, on the side

[1] Norris and Oliver, "System," pp. 902 and 903.
[2] Arch. of Oph., July, 1903.

of the diseased lacrimal passage, a defect of the cornea that renders it peculiarly vulnerable to infection, such as an ulcer, a cystoid cicatrix, or partial staphyloma. (3) If the patient is or is soon to be so circumstanced that prolonged conservative treatment is out of the question.

Extirpation is usually done under complete narcosis, though I have frequently made the operation without an anesthetic, with comparatively little inconvenience to the patient and very decided advantage to the operator. Anesthesia, by the Schleich process I do not approve of, for it interferes with that nice differentiation of tissue that is one of the greatest requirements for the success of such surgery. Cocain solution put into the opening is useless for the relief of pain, and worse than useless because of its effect on the blood-vessels.

Following the lead of those who inject solidifying solutions into the sac I have, in a few instances, tried with satisfaction the filling of the sac with melted paraffin (Wilder) that congeals at a temperature considerably higher than that of the body—say at 110° to 120° F. To obviate too free entrance of the paraffin into the nose and throat it should not be too hot, but somewhat thick—like cold molasses. Where degenerative changes in the wall have not been too great, the difficulties attendant upon the shelling out of sac are appreciably lessened by having it thus made into a firm tumor. One of our internes, recently serving in the Illinois Eye and Ear Infirmary, Dr. Fullenwider, suggested the use of fine, dental plaster which seems to answer yet better than the paraffin. Those substances, the paraffin melted (previously boiled) and the plaster, made into a thin emulsion with sterilized water to which a little salt is added, are injected through the dilated punctum by means of the syringe described on page 129, using the conical canula. C. R. Holmes, of Cincinnati, uses a thick paste of starch colored with iodin, and Valude, of Paris, has recommended spermaceti. One must be careful not to use undue force in the performance, else a rupture will occur and the material be driven into the adjacent tissues. Should this occur in the use of a non-absorbable material and steps be not at once taken to remedy, either a permanent deformity or a subsequent operation will be the result. Therefore, if the surgeon is aware of such an accident before closing the external incision,

the material should be dissected out. The patient should be prone upon his back and all ready for the operation of extirpation. The inferior nasal meatus is tamponed with vaselined cotton to prevent blood or other fluid from entering the nose, throat, and larynx.

All pus or other fluid is first thoroughly expressed from the sac and canaliculi, the cavity washed out and the liquid again expressed. If paraffin is put in, it is then hardened by applying crushed ice or

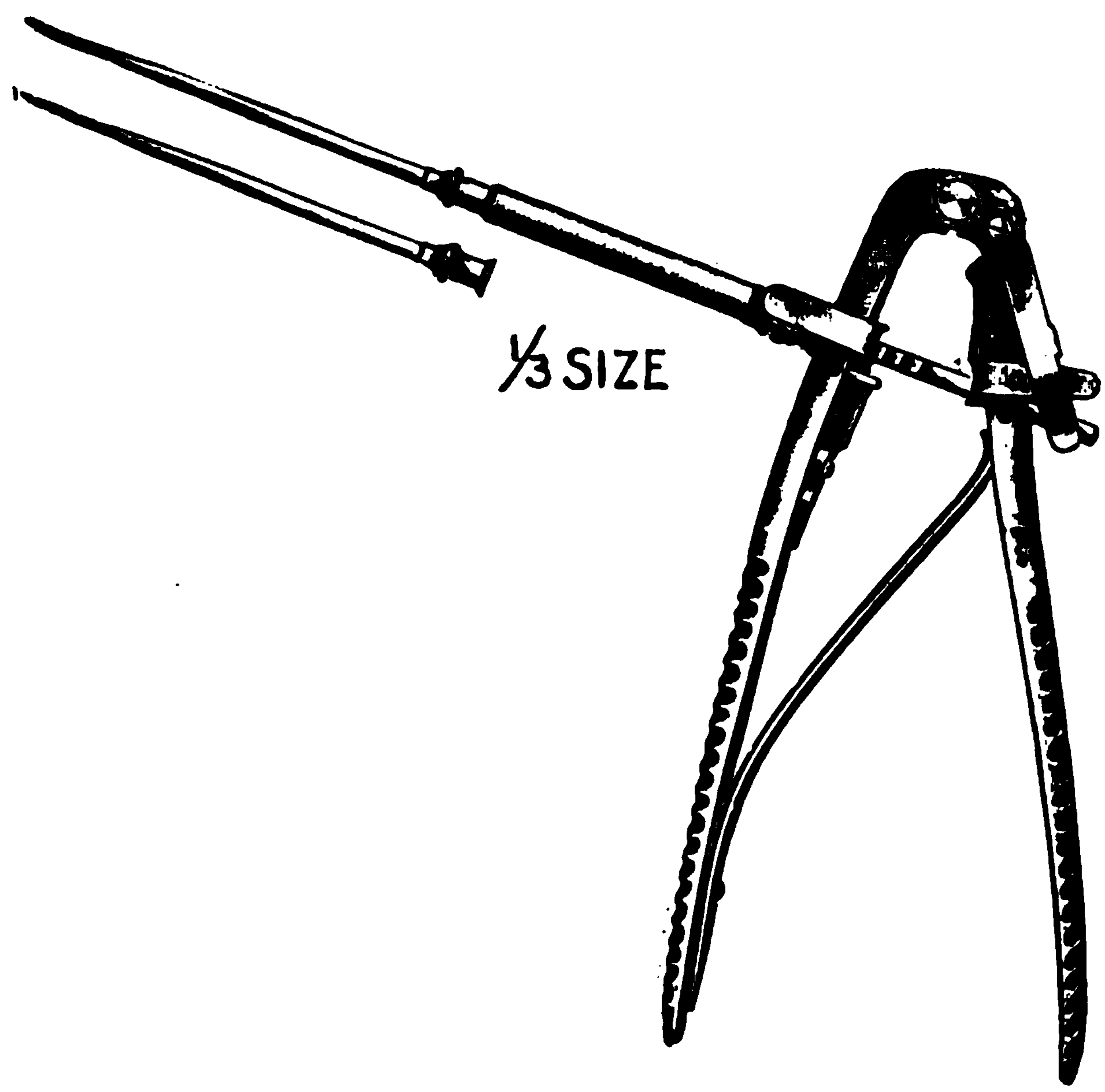


FIG. 58.—Broeckaert paraffin injector.

a cooling spray, as of chlorid of ethyl, to the overlying skin. If plaster, a few minutes is given for it to set. This throwing in of a hardening substance serves to make a mould not only of the sac, but also of the canaliculi, and does away with the need of inserting probes for purposes of orientation. Probably a less uncertain method of filling the sac, and one as well calculated to facilitate the extirpation, is that of Jocqs, of Paris, which consists in making a small opening in the anterior wall as soon as the sac is reached and packing the entire organ with absorbent cotton. Another feasible plan is to fill the sac with cold paraffin, of relatively low melting-

point, by means of one of the powerful injectors made for that purpose (Figs. 58 and 59).

One of the good points mentioned by Czermak in this connection is the occlusion of the lids during the operation in purulent cases with strips of adhesive plaster. He reasons thus: through the action of the retractors in holding open the wound, the palpebral fissure gapes, the corneal epithelium dries and exfoliates or cracks, and discharge from the puncta coming in contact with it might result in serious infection. This, of course, would prevent the use of probes passed into the sac as guides.

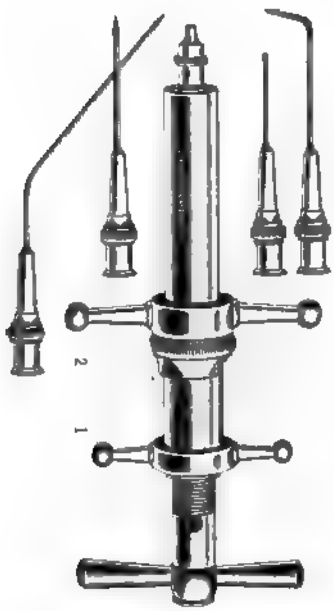


FIG. 59.—Beck-Mueller paraffin injector.

Anatomical Notes.—The inferior nasal quadrant of the orbital rim is formed by a sharp ridge on the nasal process of the superior maxillary bone. Midway of this ridge is a prominent convexity which is the ***anterior lacrimal crest.*** Immediately behind this is the *lacrimal groove* or that portion of the lacrimal fossa belonging to the superior maxilla. The other, or posterior part of the fossa, is formed from the delicate lacrimal bone, and is bounded at the back by a slight ridge—the *posterior lacrimal crest.* The fossa ends below in a short, round bony canal, leading to the inferior meatus of the nose. Fossa and canal lodge, respectively, the lacrimal sac and the nasal duct (see Fig. 60). A sharp oval is marked on the drawing to show the place of attachment of the anterior branch of the *tendo oculi,* or *internal canthal ligament.* This branch is bifid, one prong for each tarsus. Back of this, with only thin fascia intervening, is the upper extremity, or cupola of the lacrimal sac (see Fig. 61), behind which, likewise, is the posterior branch of the tendo oculi, and behind that is the *muscle of Horner.* The last two are attached to the posterior lacrimal crest. Separating this whole mechanism from the deeper structures of the orbit is a

stronger fascia, the *septum orbitale*. The opening of the united canaliculi is seen between the branches of the tendo oculi. The cupola of the lacrimal sac rises to about the level of the upper edge of the tendo oculi. Fig. 62 shows the arrangement of the blood vessels of this vicinity. This drawing makes clear why the incision should not lie to the nasal side of the rim of the orbit; and why

FIG. 60.—1, Anterior lacrimal crest. 2, Lacrimal groove 3, Posterior lacrimal crest. 4, Attachment of tendo oculi

one should be careful, in loosening the cupola, lest copious bleeding be caused by wounding the vessels that connect the facial and the ophthalmic systems. Different subjects vary greatly as to the depth at which lies the lacrimal sac.

The Technic. First step.—With a convex edged scalpel an incision is made over the sac, beginning just beneath the *tendo oculi* and extending about two and one half centimeters down and out, following the natural sulcus that marks the inferonasal rim of

the orbit (Fig. 63). In case the subject is one of those in whom the sac is not deeply situated a shorter incision would suffice, but there is no drawback to one of the length here specified, and the task is perceptibly lightened by having a generous opening. So situated, the incision avoids the larger blood vessels—i.e., the branches of the facial artery and vein called *angular*—and the scar is least conspicuous. The tissues are deliberately divided, layer by layer, first the skin, second superficial fascia, third orbicularis, and fourth

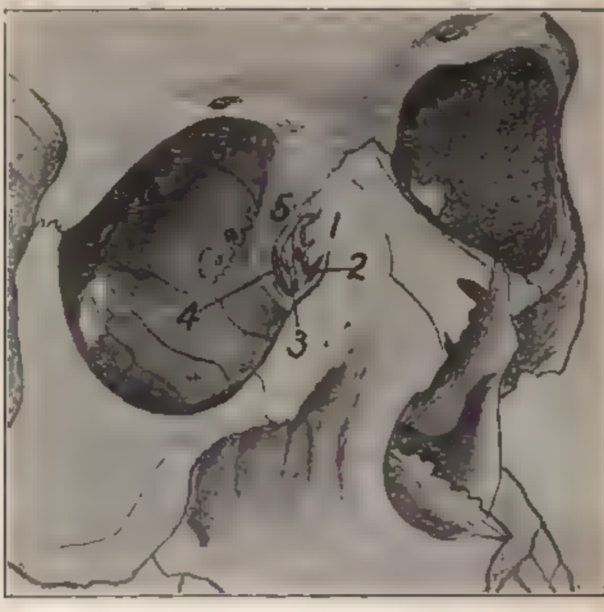


FIG. 61.—1, Anterior branch of tendo oculi. 2, Lacrimal sac. 3, Posterior branch of tendo oculi. 4, Horner's muscle. 5, Septum orbitale.

the deeper fascia, so as to come with discrimination down onto the anterior wall of the sac, and keeping all the while close in behind the anterior lacrimal crest. Caution is required in dividing the last layer or the sac may be opened. Diligent sponging is kept up and the lips of the deepening and broading wound are held well apart by squint-hooks or Desmarre's retractors, or if an assistant is not available, by Müller or Eversbusch speculum (Fig. 64).

Second step. When the smooth, red membrane composing the offending organ is exposed, blunt dissection or very careful cutting

around with dull pointed scissors is begun: first, loosen the outer or lateral side, then the inner or median side, then the back, which lies deep in its fossa, then up about the cupola. The shelling-out of the sac is greatly facilitated by passing a strabismus hook behind it as soon as its body is exposed. This can, by alternately pulling gently upon it and working it up and down, be made to assist

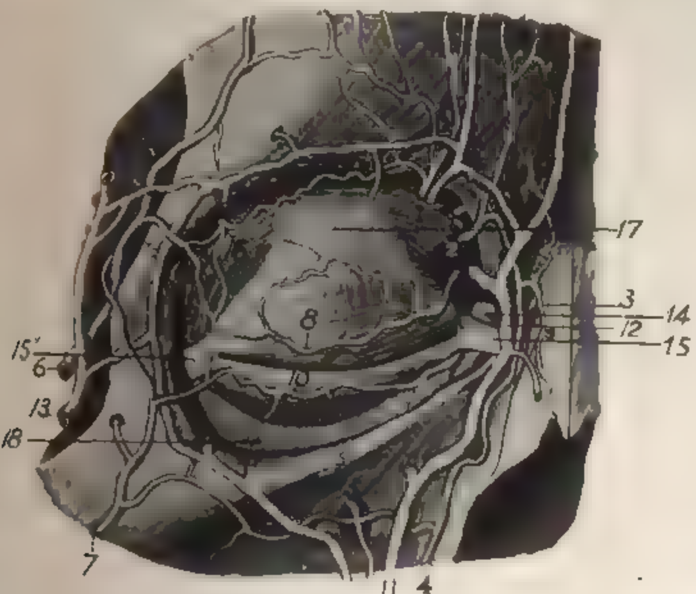


FIG. 62. 1, Supra orbital artery and vein. 2, Nasal artery. 3, Angular artery. 4, Facial artery. 5, Infra orbital artery. 6, Branch of superficial temporal artery. 7, Malar branch of transverse artery of the face. 8, Superior palpebral artery. 9, Anastomoses. 10, Inferior palpebral artery. 11, Facial vein. 12, Angular vein. 13, Branch of superficial temporal vein. 14, Lacrimal sac. 15, Internal canthal ligament. 15', External canthal ligament. 16, Lacrimal artery. 17, Ligament of the tarsus. 18, Tarso-orbital fascia. (*After Testut.*)

materially in the loosening process. Scrupulously avoid cutting the sac, the canaliculi, the *tendo oculi*, the inferior oblique muscle, or *making an opening in the tarso orbital fascia or septum orbitale.* This last is about the gravest accident that could happen during the operation in question, as it could lead to septic cellulitis of the orbit, to loss of sight through necrosis of the cornea, or through strangulation of the optic nerve, or infection of the choroid, or to death itself, by ascending meningitis or by thrombo-phlebitis

of the sinuses of the dura. Should, by any chance, a wound be made in this fascia, the opening should be thoroughly disinfected and tightly closed with silkworm or catgut sutures *before continuing*

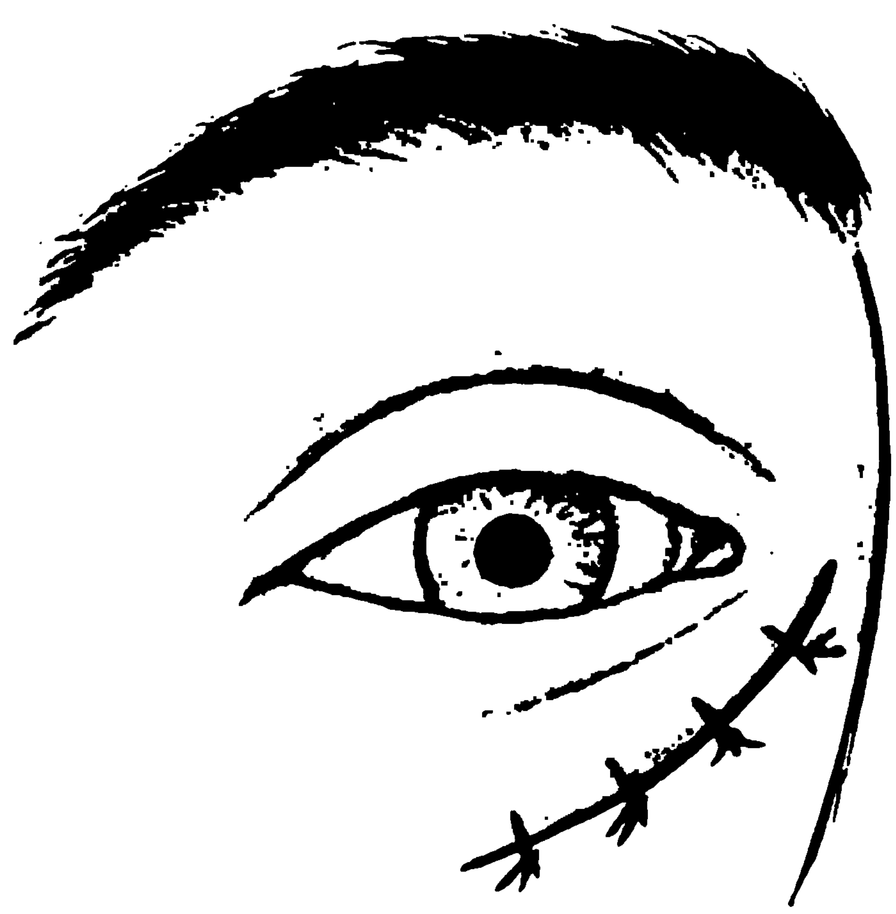


FIG. 63.—Incision for lacrimal extirpation. After the incision is open the whole is retracted and drawn upward and inward.

the extirpation. In working deep in the lacrimal fossa, remember the frailty of the lacrimal bone composing the posterior half of that depression.

Third step.—After the sac is loosened from all attachments, save

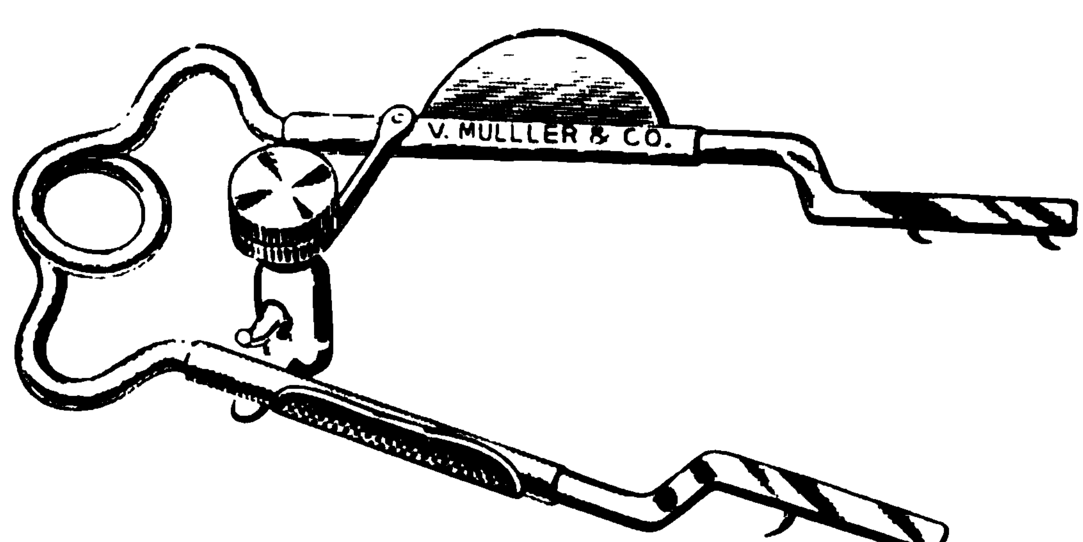


FIG. 64.

the common and nasal ducts, proceed to divide those with the scissors. First the former. Here, if much traction is made upon the sac while in the act, the puncta are apt to be inverted or drawn

inward, and in cutting off the canaliculi one risks making button-holes of the lids and skin about them. Having freed the upper portion it is grasped with broad fixation forceps and held up while the scissors are passed down into the nasal opening to divide the lower end or, as preferred by the writer, to loosen and remove it as far as the nasal cavity. Profuse hemorrhage is rather to be expected, though the above described manner of making the incision,

FIG. 65.—Extirpation of lacrimal sac. Deep fascia opened showing sac

together with firm pressure of its inner lip against the bones of the nose, the use of a broad Desmarres retractor beneath the inner lip of the incision to compress the vessels against the nasal bone (Fig. 65), torsion of the larger spouting vessels, the instillation of 1-1000 solution of *adrenalin chlorid*, or copious douches of very hot water, or, better still, hot sublimate solution will serve to keep the bleeding easily within bounds. Every trace of the sac must be got rid of. It often happens that its walls are so tender that, in spite of the most

cautious handling, they are torn. I have found that in such instances the fingers may with advantage be substituted for the forceps, to hold it, after freeing its upper end. If it is highly degenerated and amorphous, one cannot always hope to get it out intact, but must be content to sponge out the cavity as dry as possible, search for detached islands of the walls and mucous lining, pick them up with the forceps and excise them with the scissors. A thickened, tough sac can easily be shelled out entire. Where carious bone is present it is scraped away with a hard, sharp curet, no matter if it be that of the inner wall of the fossa or lacrimal bone, whereby an opening is made into the nasal cavity. Any granular masses also undergo curettage, and this sort of cleaning out is carried down into the nostril. As a proper finish, a small olive-tipped electrode is used to cauterize the nasal end of the canal. This last, however, *must not be done so long as the inflammable gases from the anesthetic are near about, else an explosion will ensue.*

Once in a while *cutting of the internal canthal ligament* is an inevitable part of the operation, as when a fistulous opening has been established above it, though the writer prefers leaving it intact whenever possible. The incision is then extended up through the ligament. After the fistula has been dealt with—i.e., its tract has been excised—and before closing the external wound, it is best to unite the severed fragments of the ligament by a catgut suture. As much of each canaliculus as practicable, without buttonholing at the punctum, is removed, and if there are any misgivings as to the capacity of what remains to make trouble, they may be obliterated by searing their linings with a delicate galvano-cautery, as per Haab.

The opening having been cleansed and the bleeding stopped, it is closed by three or four pretty deep silk sutures, between and beyond which, if needed, smaller and shallower ones may be inserted. One cannot be too precise in approximating the lips of the incision. Provided the extirpation has been complete, no tent nor drain is put in. This is done only when there is some doubt as to thoroughness.

The dressing consists of the usual wet sheet of cotton, the thick, dry pad, and the wet netting, monocular bandage; and sufficient pressure must be kept up to cause obliteration of the

cavity. It is essential that a ball of cotton be placed immediately over the wound, between the wet layer and the dry pad, to insure such obliteration. The sutures are removed just as early as the condition of the wound will allow. If this be in forty-eight hours, all the better. Where a tent is required as a drain or to induce healing by granulation from the bottom of the opening, a strip of iodoform gauze answers the purpose. The wound is closed at either extremity and the gauze is left projecting from the middle. The bandage is changed daily—so is the tent if used—until permanent closure is effected.

Obliteration of the Sac.—This measure is indicated when, through long-standing suppurative disease, with numerous exacerbations, much scar tissue with extensive adhesions, thickening of the periosteum, bone lesions, fistulæ, and fungosities exist. The incision is made as for extirpation, except that it includes the front and outer wall of the sac and, if necessary, the internal canthal ligament. After widely separating the lips, the cut in the front wall is extended into the nasal duct. As much as practicable of the sac is dissected out, the rest, together with the fungosities and the carious bone, removed by scraping with a strong, sharp curet, and lastly, the entire cavity is rather deeply seared with the thermo-cautery. Iodoform gauze packing, the ordinary pad, and bandage compose the dressing, all of which are renewed daily under antiseptic irrigation, until the wound heals from the bottom. Later it may be necessary to repeat the operation one or more times.

Fistula of the lacrimal sac will sometimes require an operation for its cure, when the indications for obliteration or extirpation of the canal are lacking. A tiny fistula that pours out simply tears will usually disappear by the simple operation of opening up the nasal part of the canal by probing, preferably without slitting up the canaliculus, with, perhaps, stimulation of the tract by means of the galvano-cautery. A pus fistula may yield to Bowman's operation, the use of the syringe and the Tansley cannula with potent antiseptics. Failing in this, recourse may be had to the more radical measure of incision and excision of the tract and closure by sutures.

In conclusion, a watchword that will bear repeating is, *always the conservation of the lacrimal canal whenever possible.*

Extirpation of the lacrimal gland, taken all over, is an operation frequently performed, yet in the life of even the busiest ophthalmologist in general it is resorted to very rarely. Truc[1] classifies the surgical measures here considered, epigrammatically, as follows:

The extirpation of the whole gland is an operation of *reserve* (extremity).

The extirpation of the palpebral gland is an operation *de choix* (option).

The extirpation of the orbital gland is an operation *de nécessité.*

The indications, are neoplasms, chronic inflammations, degenerations, and persistent, external fistula of the gland, also annoying epiphora remaining after the permanent obliteration of the lacrimal canal.

Like extirpation of the sac, that of the gland is not a measure to be adopted lightly. Diseases and some benign tumors of this organ (as those from syphilis) are often amenable to other means of treatment. An external, or cutaneous, fistula, if it cannot be healed in the usual way, may sometimes be converted into an internal or conjunctival one, when the former tract either disappears spontaneously or is easily dealt with by excision. Lastly, an epiphora that has been profuse before, and for a short time after extirpation of the lacrimal sac, will often cease altogether or become so scant as to cause no inconvenience. With the passing of the irritation from the affected drainage division of the apparatus, the overactivity of the secretive part subsides.

Before proceeding to describe the surgery of the parts, permit a word as to their *anatomy*. The lacrimal gland is a double organ, consisting of a larger superior portion, the *orbital gland*, and a smaller inferior portion, the *palpebral gland*, or, as it has also been called, the accessory lacrimal gland and gland of Rosenmüller.

The **former,** surrounded by a fibrous capsule, occupies a depression in the bone, under the supero-temporal roof, or angle of the orbit. Situated above and to the outer side of the levator palpebræ superioris tendon, its inner border almost touches the outer fibres of the superior rectus, and its outer comes near the upper fibres of the externus. In size and shape it is very like an average

[1] Arch. d'opht., T. xiii, p. 280, 1893.

lima bean. It is an acinose gland, and when stripped of its capsule, it appears as a grayish, red mass of closely packed lobules.

The lower, or **palpebral gland,** only about one-half the size of the upper, is composed of rather scattering lobules, lying just external to the outer third of the upper conjuctival fornix. The lowest lobule is usually found in the immediate vicinity of the outer canthus. It may be above, level with, or even below it. The outer fibres of the levator tendon pass between the orbital and palpebral lacrimal glands. Each gland has separate and common ducts all emptying into the outer half of the *fornix conjunctivæ* about four millimeters above the convex border of the tarsus.

Removal of the whole gland has been accomplished through the fornix or transition part of the conjunctiva. It is done by first making a free canthotomy, everting and stretching upward the lid, till the superior border of the tarsus (now, of course, the *inferior*) is about opposite the bony rim of the orbit, then making an incision just below and parallel with the tarsus, from the junction of its middle and outer third and extending beyond its temporal extremity. The same incision enables one to get at and shell out both glands, but the operation is a difficult one. The conjunctival opening, therefore, is limited in its use mainly to the removal of the palpebral gland.

Extirpation of the Palpebral Gland.—Cocain anesthesia suffices. When the lid is drawn up, as above described, and the patient is made to look far downward, as he should throughout the operation, the imprint of the lobules can be seen. Should the patient be unruly, or should the eye roll involuntarily up, an assistant grasps, with strong forceps, the tendon of the superior rectus, as per Angelucci, a trick that works like a charm to steady both patient and globe, as well as to hold the latter down. A little adrenalin solution, painted on to the spot will cause immediate blanching, when the incision can be made and the gland exposed with but slight bleeding. As advised by Panas, a strong probe may be passed down behind the everted upper lid to bring the gland into better reach of hand and sight.

The incision is best made with a small scalpel having a highly convex edge. The wound is held open with the smallest-sized retractors or the tiny strabismus hooks of Stevens, and the gland

is loosened first above, then below, by blunt dissection or cutting with stub-pointed scissors. When the lobes are in view and fairly freed from surroundings, they are drawn out and severed from their posterior attachments by cutting with the scissors, from the nasal side and ending at the temporal. At this end there is apt to be some hemorrhage, but it is easily controlled by styptics, clamping, or torsion.

Extirpation of the Palpebral Portion, together with the degenerative effect entailed upon the ducts of the orbital gland, will occasionally suffice for the relief of epiphora. It is well known that atrophy of the conjunctival sac, following trachoma, results in the drying up of the source of the tears, hence the actual cautery has been applied (Chibret and Bettermieux) to the retrotarsal folds and the mouths of the ducts, with a view to the discouragement of further lacrimal secretion or the induction of atrophy of the gland. One ought to avoid unnecessary opening of the orbital fascia, fearing cellulitis, and know how to distinguish the glandular tissue from that of the orbital fat. The first-named is pink and of firmer consistency, the second, yellow and softer. A couple of fine, absorbable sutures are put in to tolerably close the conjunctival incision, or they may be omitted, and the conjunctiva and skin of the canthus are sutured together as per description—see "Canthoplasty." Canthotomy is often dispensed with in extirpation of the palpebral lacrimal gland. The levator tendon is to be scrupulously shunned, because of possible ptosis. A safer, easier, and generally preferable method for the extirpation of the larger gland is by way of the external incision.

The Operation for Extirpation of the Orbital Lacrimal Gland.—The supercilia are lathered and smoothly shaved with a razor. For the most part, general anesthesia is demanded. The exact mid-line of the stumps of the outer half of supercilia is chosen for the site of the cutaneous incision, so that most of the scar will be hidden. The convex scalpel is held in the right hand while the indicated line of the eyebrow is stretched over the rim of the orbit by manipulation of the left thumb and index. After cutting the skin from midway of the eyebrow to its outer extremity, the cut is continued just over the outer rim of the orbit to a point about on a level with the outer canthus. It is then deepened until the

periosteum is reached, then pulled downward and held open by some form of retractor. A quite fitting instrument for the purpose is the lid speculum of Landolt (Plate VIII). The tarso-orbital fascia, or *septum orbitale*, is next incised opposite the front border of the gland, and from three to four millimeters beneath the edge of the orbital rim, taking care to keep the inner end of the incision as far as practicable toward the temple, in order to keep out of the way of the levator and its nerve. The gland is laid bare, loosened with curved, dull-pointed scissors, working now closed and held pen-fashion for blunt dissection, again cutting the stronger fastenings of the gland—first below, then above—the latter being all the while slowly and steadily drawn forward, until it comes away entire. At this stage, the lacrimal artery is tied, hemostatic forceps applied to other bleeding vessels, and every means resorted to for the prevention of deep hemorrhage. (See Gifford,[1] "Extirpation of the lacrimal gland, causing atrophy of the optic nerve, through hemorrhage into the orbit.") Great care must be exercised to prevent injury to any of the external eye muscles or to their nerve supply. The cavity is washed out with sublimate solution and the opening in the tarso-orbital fascia is closed with fine gut sutures. The lips of the outer wound are put into the nicest possible apposition and held together by a few carefully placed, interrupted sutures of paraffined silk. The usual monocular bandage is applied, excepting that the pad of dry cotton is larger and extends up higher on the forehead. The patient is put to bed and kept quiet and the eye regularly inspected. The silk thread is removed as soon as the healing of the wound will permit. If signs of infection appear, the incision must be at once reopened, at least that portion of it involved by the threatening process, cleaned out, and vigorously treated with strong antiseptics.

[1] Am. Jour. of Ophthalmology, Vol. vi, p. 268.

CHAPTER IV.

OPERATIONS UPON THE EXTRINSIC MUSCLES OF THE EYE.

Strabismus.—This is a very old word, of Greek origin, whose more modern and preferable English synonyms are *squint* and *heterotropia;* and all three are terms that refer to an abnormal position of the globe whereby its visual axis fails to meet that of its fellow exactly at the fixation point. Whatever the determining or "exciting" causes of squint—whether errors of refraction, amblyopias, unawakened fusion centers, etc.—it is certain that faulty muscles are in most cases the predisposing—the real—cause. The vast majority of eyes remain free from strabismus, no matter what the state of the vision, the refraction, or other physical conditions. Of the squinting eyes, approximately only about one-third are amenable to treatment other than surgical. It is of the utmost importance, then, that one should study well each separate case, in order to determine the nature, the degree, and the contributing factors as regards both the eyes and the possessor of them; and that surgical methods should not be resorted to saving when reasonable trial of all other appropriate means has failed to remedy the defect. Then only is an operation indicated.

Kinds of Squint.—The deviation of the eye is spoken of as *lateral*, or *horizontal*, when it turns out or in; as *vertical*, when up or down, and as *oblique* when it is a combination of the two. When the eye turns inward, the squint is said to be *convergent* (esotropia); when outward, *divergent* (exotropia); when upward, *sursumvergent* (hypertropia), and when downward, *deorsumvergent*. In pure horizontal deviation inward the eyes are in the position of *positive convergence*, because the lines of fixation intersect in front of the eyes; and in horizontal deviation outward, they are in that of *negative convergence*, because the lines of fixation, if prolonged backward, would meet behind the eyes. At a matter of fact, however, in most instances the squint is a mixture of the lateral and the vertical varieties.

All squints are divided into two grand classes, depending upon whether the eyes are or are not, under certain conditions, able to assume their normal relative positions. The older and less rational terms to denote the two classes were *non-paralytic* and *paralytic*. Non-paralytic strabismus was called *concomitant*. The later and better terms are *comitant* and *incomitant*. The first includes all those in which the direction of the eyes might, through the influence of the will, the effect of artificial lenses, the action of drugs, narcosis, etc., become normal in any part of the field of fixation. To the second belong all the others, whether the squint be due to paralysis, paresis, from any cause, or to congenital shortness of a muscle. A further classification of squint is into *constant monolateral*, *alternating*, and *intermittent*. In the first class the deflection is always confined to the same eye; in the second, it is first of one eye and then of the other. In the third, the squint is absent part of the time and, when present, may be either monolateral or alternating. By far the most common form of squint is the convergent.

A still further classification is into *primary* and *secondary* squint. The former comprises all save those unfortunate cases in which deviation of an opposite kind has followed the too free severance of a muscle from the globe (overtenotomy) or the prolonged wearing of the full correction for excessive hyperopia.

Then there is that state of the ocular muscles in which there is more or less *tendency* of an eye to wander, and actual squint is prevented only by a corresponding degree of conscious or unconscious muscular effort. This is referred to as *latent squint* or *suppressed squint*. It is also the *dynamic strabismus* of Von Graefe, and the *heterophoria* of Stevens.

The same general surgical principles are applicable to all forms of squint—latent or manifest—yet they must be variously modified to answer the demands of individual cases.

With rarest exception but one eye squints, while the other fixes, and the two are designated as *squinting eye* and *fixing* or *working eye*. The fact that the squint is confined to one eye does not imply that but one eye is concerned in the defect. As first pointed out by Donders, and since abundantly verified, strabismus is usually a bilateral affection. Nor does it follow that the fixing eye is possessed of a better muscular system than the squinting one. Often

the reverse is true. Greater visual acuity, a lesser refractive error, etc., having determined it to do the work. As concerns the cases here in point, viz., those that ultimately require surgical measures, it may be assumed, for all practical reasons, that the defect is purely a muscular one, and that *the muscle usually concerned is that one away from which the eye turns, or its fellow of the other eye; or*, as is most often the case, *both of them*. That is, these muscles are inefficient or abnormally weak, rather than that their opponents are overactive or too strong. The last mentioned, however, was the original idea, and upon it was based the primitive operation of strabotomy. To this day the Germans call the muscle toward which the eye deviates the *Shielmuskel*—the squint-muscle—and refer to the one truly at fault as merely the *antagonist*. Every close and experienced observer, in studying the conditions of the muscle or muscles actually involved in the squint, must have been aware of the anomalies so often present—anomalies of development, of attachment to globe, adhesion to the fibrous capsule, etc.

The different surgical means that have been devised for the cure of squint may be thus denominated and arranged according to their origin:

1. Strabotomy { *a*. Myotomy. / *b*. Tenotomy.
2. Tendon advancement, or prorrhaphy.
3. Capsular advancement.
4. Tendon shortening { *a*. Folding or tucking. / *b*. Resection.
5. Tendon recession.
6. Operations upon the check ligaments.
7. Tendon lengthening.

These various measures are employed either singly or combined; as, for example, a muscular with a capsular advancement, to which may be added a tendon resection, or a tendon folding, and so on.

1. **Strabotomy,** or the cutting of an ocular muscle, for the cure of strabismus, like the entire surgery of squint, is of comparatively recent date. The first to conceive of such a thing was the gifted English charlatan oculist "Chevalier" John Taylor,[1] in 1738;

[1] De Vera causa strabismi, Lisbon, 1739.

though he did not carry his idea into effect, contenting himself merely with a "fake" operation, viz., snipping the conjunctiva of the affected eye, then closing the fixing eye by means of adhesive plaster. Of course, the operated eye immediately became "straight." By the time the plaster was removed the operator was paid and gone to other fields. We have some muscle snippers in our own time who could give the smooth Chevalier pointers.

A similar suggestion to that of Taylor, i.e., the division of a muscle to correct a squint, was made by Eschenbach, of Rostock, in 1752. Yet, singular to relate, for a hundred years from the time of Taylor's hint no attempt was made to put the notion into actual practice. This was left to be first done, but only upon the cadaver, by Stromeyer, of Hanover, in 1838, and by Dieffenbach, of Berlin, upon the living subject in 1839. Dieffenbach's early operation was essentially a myotomy which concerned the muscle toward which the eye deviated, and as such was both defective and formidable. It consisted in a free opening of conjunctiva and Tenon's capsule, drawing forward the *Shielmuskel*—the supposed faulty muscle—and the complete severance of its body. Naturally, in an era when asepsis was unknown the consequences were often dire. Septic orbital cellulitis and, moreover, secondary squint, with all its lamentable attendant defects, were so common that after a year or so the procedure fell into dissuse. About this time (1841) Bonnet, of Lyons, published the results of his anatomical researches, which had been conducted with special reference to the relations of the ocular muscles and the various ramifications of the fibrous capsule of the eye, and their bearing upon the surgery of squint. This led to subconjunctival myotomy, which lessened somewhat the dangers of infection, and later, mainly through the efforts of Jules Guerin (Nantes and Angers, about 1845) to the less harmful and simpler operation of tenotomy, and still later (about 1849) even to subconjunctival tenotomy. By these means not only was infection still further barred, but secondary strabismus became a less frequent sequel. The operation was taken up with a vim by A. v. Graefe in 1853, and by George Critchett, of London, in 1857, and improved and refined till, at their hands, it reached practically the status in which it is found to-day.

Von Graefe's Method.—The tendon is fully exposed by either

a horizontal incision through conjunctiva and capsule of Tenon, passing over the insertion, or, as was most often preferred, by a vertical incision between the insertion and the cornea. The conjunctiva is undermined toward the neighboring canthus with blunt scissors, the Graefe strabismus hook is inserted beneath the tendon, he latter lifted somewhat and severed from the sclera with blunt scissors as close as practicable to its attachment. The hook is reinserted to search for any uncut fibres of the tendon, which, if found, are also divided. Lastly, the conjunctival wound is closed by a fine suture.

Von Arlt, of Vienna, made tenotomy after the manner of v. Graefe, save that he picked up the exposed tendon with the mouse-tooth or toothed fixation forceps, instead of with the hook, but used the hook in finding and severing remaining fibres. This surgeon was most circumspect in determining the position and extent of his incision through the membranes, choosing a small horizontal one over the center of the tendon for the lower degrees of strabismus and a freer vertical one over the insertion for the higher grades. If it was feared that the separation of the muscle from the globe was extreme, the aponeurosis of the tendon was included by the suture which finally closed the vertical wound; if not, only the conjunctiva was included.

Critchett's Subconjunctival Tenotomy.—With strong mouse-tooth forceps, pressed firmly upon the globe over the lower border of the tendon, just behind its insertion, a horizontal fold of conjunctiva and underlying capsule of Tenon is picked up and cut crosswise with blunt-pointed scissors close to the forceps, if possible dividing both membranes at one snip, though it may be necessary to pick up the capsule in a similar fold and incise it separately. Thus a vertical wound opening is made. The lower border of the tendon is now brought to view by gently lifting with the forceps the fold of membrane still retained in its jaws and touching the wound with the sharpened point of a cotton sponge. A delicate, flattened Graefe hook is then inserted, point up, beneath the tendon, pushing it snug up to include all the fibres, the forceps relinquished by the left hand for the hook, which is slightly raised. One point of the delicate blunt-pointed scissors is passed beneath the tendon close to its attachment and the other beneath the conjunctiva, and the

tenotomy accomplished by successive snips of the scissors, cutting from the heel to the point of the hook. As in the Graefe method, stray fibres that have escaped the scissors are sought and divided. If still greater effect is desired a subconjunctival incision is made vertically in Tenon's capsule, a little back of the point where the tendon was cut. Unless there is a tendency of the conjunctival wound to gape, no suture is employed.

Snellen's[1] Subconjunctival Tenotomy.—The Utrecht master has given an invaluable procedure. The conjunctiva and capsule are picked up by strong mouse-tooth forceps in one horizontal fold, as in the Critchett operation, not over the border of the tendon but over its center, and, if possible, the tendon itself is contained in the bite, which is made a little back of the insertion. The entire fold is lifted and cut athwart by the blunt scissors close to the forceps, on the corneal side, and the wound peered into to see whether or not the tendon has been nipped. If not, its center is caught up in a longitudinal pleat in which a tiny, perpendicular buttonhole is cut. Still holding up the fold, a small hook is introduced, point upward, at this hole, and the upper half of the tendon severed by cutting with the blunt scissors from heel to point of the hook beneath the membranes and between the hook and the insertion. Still holding with the forceps, the hook is placed, point downward, under the lower half of the tendon, and that, in like manner, is divided. After the example of v. Arlt, if greater effect is desired the incision in Tenon's capsule is extended, subconjunctivally, both above and below. The conjunctival wound may, according to the judgment of the operator, be closed by a thread, or its edges simply cleansed and approximated by means of the forceps. Snellen, in beginning his operation, sometimes grasps the tissues in the opposite sense, i.e., over the center of the tendon, but into a vertical fold.

George T. Stevens, of New York, has somewhat modified Snellen's method into a partial tenotomy and has devised a set of delicate strabismus instruments (Plates II and III). Whatever may be said concerning the modification, it is certain that the implements leave little to be desired along this line. The present writer adopted the Snellen operation and the Stevens instruments more than fifteen

[1] Klin. Monatsbl. f. Augenh., 1870, S. 26.

years ago, and has since employed them in preference to others. The following constitutes the

Author's Mode of Making the Snellen Tenotomy.—Assuming that we have to do with a case of convergent squint of the right eye, the eye is prepared and anesthesia—local or general—is produced. Local anesthesia is preferable. The patient lies on a table, at the head of which the surgeon stands. The blepharostat is put in place and the conjunctival sac thoroughly irrigated with warm boric solution, the remains of which are sponged away. If the eye is under local anesthesia, as is the rule, the patient is instructed to look all the while to the extreme right. The outlines of the tendon and insertion of the internus can now be indistinctly perceived. If they are about in their normal positions, the mouse-tooth forceps is placed in contact with the globe, with jaws separated some six or eight millimeters, and just below the center of the tendon in such a way as, when bearing firmly down and closing the forceps, to form a vertical fold three or four millimeters in height, composed of conjunctiva, capsule, and tendon. Holding the forceps tightly, the fold is slightly lifted, and with the Stevens scissors, with their concavity directed toward the operator, one essays by a single sturdy snip to cut through all three layers of the fold close to the forceps, thus making in each a small horizontal incision.

The forceps, still holding fast, is slightly tilted away from the operator to cause the wound to gape. If the attempt has succeeded, the bare shining sclera is seen at the bottom of the wound. If necessary, the tip of a cotton sponge is applied to the opening to clear away the blood. The scissors are now exchanged for the Stevens hook, which is inserted, point downward, beneath the lower half of the tendon, close up to its insertion. The fold held till now by the forceps is let go, the membranes below the cut are seized with the forceps and pushed downward so as to expose the point of the hook, behind which, by tilting it, they are caught. Now, making traction outward and upward with the hook, held in the left hand, the lower half of the tendon is severed from the globe close to its attachment, cutting carefully with the scissors from the heel toward the point of the hook. Those who make complete tenotomies will here, of course, divide the entire half of the tendon. It is the writer's invariable practice, however, except in the opera-

tion of *tendon recession*, to leave both borders of the tendon, or at least its lateral fibrous expansions, intact. The section is, therefore, stopped a millimeter or so short of the lower edge of the tendon. The hook is held beneath the uncut border, the scissors are exchanged for the other hook, which, in turn, is placed beneath the upper half of the tendon, the first hook is removed, the membranes pushed beyond its point with the forceps, and, again taking the scissors, the upper section of the tendon is made precisely as had been the lower—that is, sparing the border. The result of the procedure is a small horizontal incision in both membranes and a vertical button-hole in the tendon, which separates all of its more central fibres from their former attachment. The eye is again douched with the warm boric solution, as it has been several times during the operations with the double purpose of cleanliness and to prevent dryness of the corneal epithelium, and the membranes are carefully re-arranged. No suture is put in.

I make this operation only as the first step in muscular advancement, *never as a single surgical measure.* The advancement proper, as described further on, is then proceeded with.

Accidents and Complications, Immediate and Consecutive.—While the operation of tenotomy, as performed to-day, is one of the safest of surgical procedures as regards any serious instant mishap or any grave sequel that threatens actual loss of the eye, yet these very things have happened, to experienced surgeons as well as to the tyro, in this branch of his art. Not only are these greater dangers to be avoided by every possible means, but there are a number of lesser untoward happenings to be guarded against. Among the immediate are:

Hemorrhage from the conjunctiva and Tenon's capsule. The larger vessels of these membranes are, as a rule, plainly visible and can be avoided by cutting to one side of them. This is particularly true of the capsule, where a large vein is seen to extend longitudinally over the centre of tendon and muscle, and it is through wounding of this that the worst hemorrhages come. The most to be dreaded from the bleeding is a large hematoma, which is in the way, and tends to complicate the healing process. Because of their secondary relaxing effect upon the walls of the blood-vessels, I am very sparing in the use of such things as cocain and adrenalin. Indeed, I have

practically abandoned the last, and as to cocain, limit both strength and quantity to the minimum that will produce anesthesia, and attempt to make the operation under the primary effect: one minim of a 2% to 4% solution dropped onto the site of the tenotomy twice, or, at most, three times, with two-minute intervals; then a wait of five minutes after the last drop before beginning the operation, is the rule. Subconjunctival injections of these solutions I never resort to, not so much because of the danger, which is slight, but because of the inconvenience occasioned by the ensuing infiltration. Another source of hemorrhage is indiscriminate cutting about with the scissors beneath the conjunctiva and Tenon's capsule. All such dissection is absolutely uncalled for, and pernicious, save in cases where one encounters cicatricial tissue, as from a former operation. It were also easy, by thus snipping, to wound the deeper layers of the orbital fascia, exposing the fat and risking what is perhaps the gravest accident that ever occurs after tenotomy of a rectus, viz., *septic orbital cellulitis.*

Perforation of the sclera in severing the tendon has often occurred, and is a casualty as inexcusable on the part of the operator as it is serious for the operated, yet nothing but the greatest watchfulness will prevent its happening to even the most skilled and experienced surgeon. To avoid it one should never use pointed scissors, never pull up the tendon strongly and cut obliquely from behind its insertion close down to the sclera, and never cut too much under cover of overlying membranes. Whenever possible the bite of the scissors should be squarely at a right angle to the long axis of the muscle.

Tenotomy of the wrong muscle or upon the wrong eye is to be guarded against. To tenotomize the corresponding muscle of the eye not intended were less harmful than pardonable, seeing that squint is usually the result of a binocular defect. Should the opposite muscle of either eye be cut, however, it should be at once picked up and reattached to the globe by one of the various suture methods employed for advancement, though the cut end of the muscle should, of course, be drawn up only far enough to meet the stump from which it had been severed.

Of the *consecutive accidents*, by far the most common come mainly from a *too complete section of the tendon.* They are:

1. **Retraction of the caruncle,** leaving only a dark hole where this little body should be.

2. **Lack of motility** of the globe in the direction of the operated muscle.

3. **Exophthalmos,** with its attendant widening of the palpebral fissure, or *proptosis.*

4. **Secondary squint,** or the ultimate deviation of the globe in the contrary direction to that for which the tenotomy was made.

Knowing the cause, the preventive is obvious and readily available; yet, having once occurred, the remedy, whilst it may be quite manifest, is not so easy of application. To my mind the proper thing to do, *whether secondary strabismus exists or not,* is to try to restore the relation of the muscle to the globe, even, if need be, at the cost of re-establishing the original squint at the same time. This would be a big choice of the two evils and could then be dealt with more intelligently and scientifically. To widen the palpebral fissure of the other eye for the proptosis, for example, as has been recommended, and even practised, is preposterous. If, on the other hand, one is at once aware of having gone too far in any direction, he ought, then and there, to make an effort to set matters aright. If, for instance, he thinks the capsule has been too greatly pushed back, or too freely opened, or knows that the tendon had been too extensively divided, or that the extreme lateral fibres have been cut on one or both sides, a small, absorbable suture should be so put in as to correct the error. Even after the lapse of two or three days, if it is evident that a blunder has been made along this line, it is not too late to try to rectify the consequences; for, while union may be firm, there being no scar tissue as yet, the parts may be still separated without difficulty. Aside from the bad results of a complete tenotomy may be mentioned those of extensive incisions in the conjunctiva and in Tenon's capsule. This is especially true if they are made in the vertical sense. This alone leads to retraction of the caruncle, slow healing, extensive adhesions, granulomata, and other complications. Whether or not one chooses the better direction for these incisions, i.e., the horizontal, he should see to it that there is not undue gaping of the cut edges of the membranes.

If *exuberant granulations* spring up, or a polyp occurs, at the site

of the tenotomy, a drop of cocain solution and a snip of the scissors constitute an effectual remedy.

In warding off other sequels, such as conjunctivitis, tenonitis, etc., absolute cleanliness of the eye, the instruments—in short of everything concerned—is the best safeguard. Add to this perfect occlusion of the eye and the strictest quietude of the patient after the operation, and about all is done that can be. Often too little attention is paid to the dressing of the eye after this sort of operation. In view of the fact that so many of the subjects are children, one should be all the more exacting in these respects. I find that the use of the wet netting bandage, and flexible collodion to fix it, makes an excellent dressing in every way. (Described in chapter on Dressings.) *Extensive adhesions* and *scar tissue* after tenotomy are to be avoided chiefly because by their action in binding the tendon and tension on the check ligaments they restrict the movements of the globe. They are usually the result of unnecessary traumatism at the time of the operation, mostly through futile and aimless poking and gouging with hooks, slashing with scissors, and mangling with forceps.

There is no advantage in a subconjunctival tenotomy over one that is made with the tendon in plain view; much to the contrary. In the first place, one's work is more uncertain, being out of sight, and precision is the key-note to success. In the second, it has been proven that there is less apt to be unfavorable reaction after the open method, seeing that bacteria and blood can be much more thoroughly got rid of.

As to *dosing the effect* of a tenotomy; to assert that so much cutting in a given manner means so many degrees of permanent rotation of the globe away from the muscle attacked has always seemed to the writer to be the acme of absurdity. Granting that a tendon can be set back a specific distance, what assurance have we that it will remain in that position? It is pretty certain that if the borders of the tendon are both left intact and if the tenotomy has been accomplished with the minimum of traumatism, the ultimate result will be *nil*. After the complete tenotomy it would seem to be merely a question as to how much, or how little, harm is done. The result is purely problematical. If the tendon has not been too greatly loosened from its sheath, it may creep back to its place again

or it may recede to a greater or a lesser distance, depending upon wherever it can find an attachment or can come to rest. To divide the tendon all from one side leaving a single border uncut tends to produce torsion of the globe.

Probably the least doubtful way of obtaining a definite degree of effect is to make section of all but the outermost fibres of the tendon, then resort to one of the several guy-threads such as have been invented by Graefe, Knapp, Grüning, and others. These consist mostly in passing a ligature through the episcleral or scleral tissue, close to the cornea on the opposite side to that whereon the tenotomy occurs, whereby the globe is pulled into extreme duction, when the ligature is coiled upon the temple or nose as the case may be, and there fastened with collodionized cotton. The ligature is a source of both pain and danger.

Another somewhat less positive but much safer method is to make section of the entire tendon, drop it back the desired distance, and fix it there by a thread. This operation will be described later under "Curb Tenotomy."

Were I asked to name the indications for tenotomy of a rectus muscle, I should say buttonholing the center of the tendon at the time an advancement is made on its antagonist to prevent, by weakening it, the cutting out of the thread used in the advancement, and complete tenotomy only in case of abnormal shortness of the muscle, as it is found in certain cases, as, for example, congenital strabismus—then always with the curb suture just alluded to. *These are, in my opinion, the only two indications.*

2. **Tendon Advancement.**—Dieffenbach, of Berlin, attempted advancement of the retracted muscle for the secondary squint that occurred after one of his myotomies as early as the year 1842, but the results were not gratifying. Guérin,[1] of Nancy, was the first to make practicable such a procedure. He, too, was incited to make the operation by a desire to relieve secondary squint, many instances of which were all about—the ugly fruits of the (then) new fad of muscle-cutting. Just the precise technic these surgeons adopted I have not, as yet, been able to ascertain. One of the first published descriptions of an advancement operation is that of

[1] Ann. d'oculist., vol. xxii, 1849.

Albrecht von Graefe[1]. It is substantially as follows: Supposing we have to do with a divergent strabismus of the right eye (Fig. 66). The conjunctiva and Tenon's capsule are incised over the insertion of the internus, and its tendon completely severed from the globe. The membranes are then opened over the insertion of the externus, its tendon lifted on a hook, a ligature is passed through the middle of the tendon, close to its attachment, from the scleral side outward. The ligature, which includes about 1/2 the width of the tendon, is tied and given to an assistant. While traction is made with the ligature toward the cornea, the operator gently pushes the hook toward the outer canthus; from 1/2 to 3/4 the width of the tendon is divided by the scissors, some 2 mm. behind the thread. The degree of section is proportioned according to the resistance the muscle is supposed to offer against rotation to the other side. The eye is now turned into extreme adduction, and the ligature is fastened to the nose by diachylon plaster (or other adhesive), care being taken to so place the thread that it will not infringe upon either lid border, i.e., exactly in line with the closed palpebral fissure. If the bridge of the nose is not sufficiently high to hold the ligature clear of the cornea, it is built up by means of the diachylon plaster. Such is von Graefe's famed "Faden-operation" (thread operation) that has been so much criticised and ridiculed. As a matter of fact, it is not by any means one of the poorest of the many clever devices of this genius in ophthalmology. It embodies the partial tenotomy of the stronger muscle and the (intended) advancement of the weaker, and provides an ingenious and practical means of holding the globe in a favorable position for the reattachment of the advanced mucle. True, von Graefe abandoned it because of injury to the cornea sustained by certain of the operated through

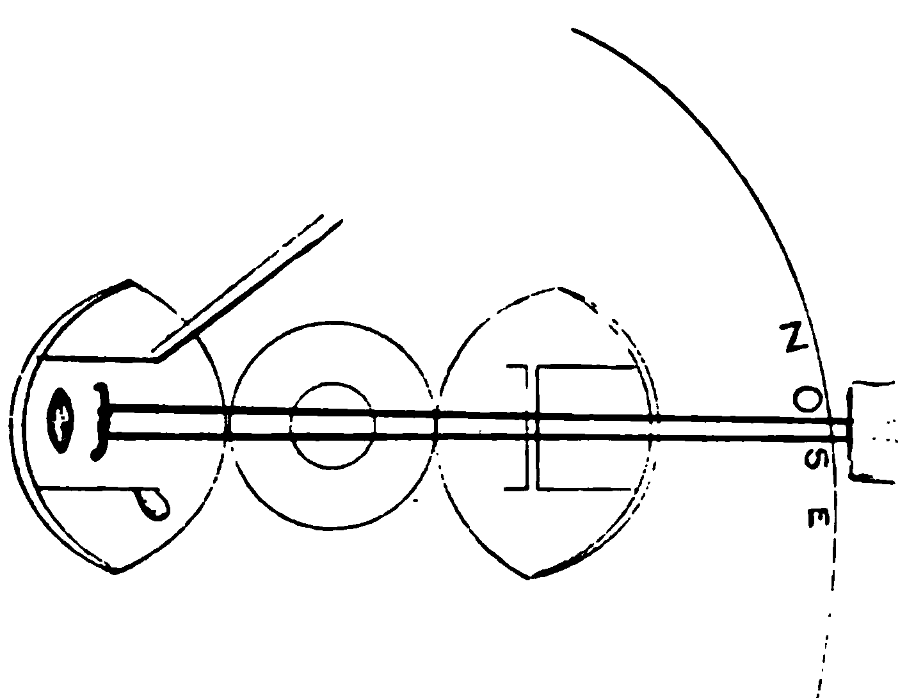


FIG. 66.—Graefe's "faden operation."

[1] Arch. f. Ophth., iii, No. 1, 1857, p. 342–344.

contact of the ligature. But with the ligature anchored at the insertion, with vertical buttonholing of the tendon, careful fastening of the ligature on the nose by collodionized cotton, and with modern methods as to antisepsis and dressings, this source of danger would cease to be a factor; yet there would still remain the discomfort to the patient, for the pain was said to be severe during the several days the ligature was left in. Where the operation chiefly failed was that the internus (in the case cited) was expected to advance of its own accord and take its new hold upon the globe, instead of retracting as it always does. Had this been brought forward and sutured before the guying, the history of the procedure might be a very different one. This was an attempted advancement *without a single suture.*

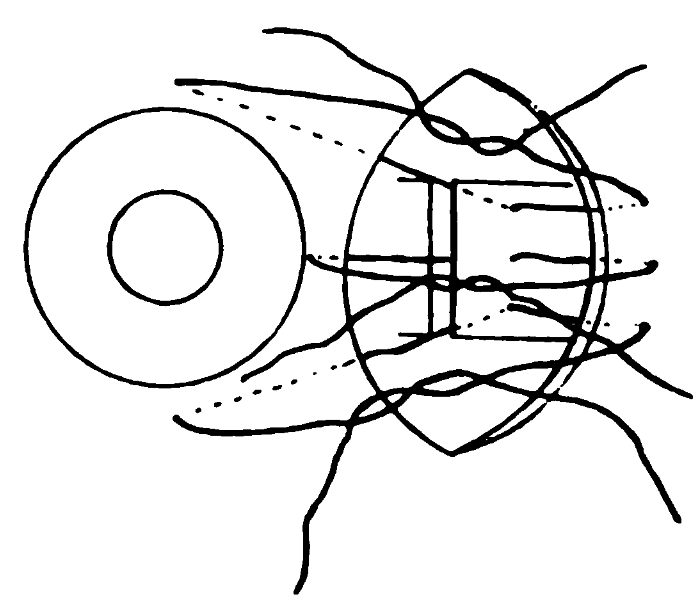


FIG. 67.—Critchett's advancement operation.

About this same time George Critchett,[1] of London, devised his multiple suture operation, which is the parent of most modern advancement methods (Fig. 67). It may be thus briefly described: A vertical incision about 1/2 inch long, is made between the cornea and the insertion of the tendon to be advanced, through conjunctiva and Tenon's capsule. This is opened up, the tendon is laid bare and lifted on a strabismus hook, seized near its middle with clamp fixation forceps, and severed from the globe flush with the sclera. If need be, a small strip is trimmed off the cut end of tendon. While an assistant holds the forceps, three separate sutures are passed downward, through the tendon, after having picked up a bite in the overlying membranes, one near each border and one at the middle. The first two threads are carried forward, beneath the conjunctiva, to emerge near the upper and lower limbus, respectively, close to the vertical meridian, while the third is given a similar hold exactly in the horizontal meridian, coming out at the limbus. The middle suture is tied first, to hold the muscle in its proper place, then the other two. When occasion demanded it, a fourth suture was put in. This operation, very slightly changed, is still the

[1] Med. Times and Gazette, Nov., 1857.

favorite method with many ophthalmic surgeons. At the hands of the majority, the fixation forceps has given way to some form of tendon clamp, and the anchorage of the needles is deeper.

Landolt,[1] of Paris, modified Critchett's operation in several important respects, chief among which was the omission of the central suture which he considered, and justly so, to be in the way of a positive and efficient advancement. Landolt[2] thus described his method in 1897: "Conjunctival incision close to and parallel with the corneal limbus. No conjunctival bridge for a meridional suture is left, since the muscle then becomes inserted not a the corneal margin, but further back, corresponding to the conjunctival incision. The conjunctiva is not detached far beyond the insertion of the tendon. A small and somewhat flattened hook is passed under the muscle, either according to von Graefe's method or, better, after grasping the muscles with a pair of forceps[3] and cutting a small hole. In this manner the whole muscle is brought flat on the hook, whereas, in the first mode, the relaxed muscle may become folded lengthwise or the hook become entangled in Tenon's capsule or the muscle fibres. An assistant now draws the muscle forward and away from the globe with the hook, and the operator, with the squint forceps, grasps the muscle at a point 1/3 of its breadth from its margin, together with the surrounding connective tissue and Tenon's capsule, behind the hook, and then passes a fine curved needle through this entire fold. After this is done on both sides of the muscle, it is pulled up by the four threads and cut between the threads and the hook. The tendinous stump is detached close to the eyeball. This is a small resection, which enhances the effect of the advancement in moderate degrees of strabismus. In simple insufficiency or small degrees of strabismus, the muscle is detached without resection. In strabismus of high degree, the sutures are introduced far behind the insertion for a more extensive resection. This done, the operator sees if the sutures are well applied. If they are not, he reapplies them, which is very easy, since the inferior surface of the muscle is now exposed. Then one needle is passed for a few *mm.* through the episcleral tissue, close to

[1] Comptes rendûs de ma clinique pour l'anneé, 1878.

[2] Knapp's Archives, vol. xxvi, No. 1.

[3] Specially designed by Landolt for use on the ocular muscles, whose teeth are placed obliquely to the long axis of the instrument.

the corneal limbus above, while the other is passed similarly below, the muscular plane. The assistant grasps the eyeball over the antagonistic muscle with a fixation forceps and rotates it toward the muscle to be advanced. Thus the operator can tie both sutures without much traction on the enclosed tissues. It is advisable to half tie both sutures before completely tying one. Thus the preponderance of the first suture over the second is avoided. To prevent confusion, white silk is used for one and black silk for the other suture. The muscle, with its covering conjunctiva, not unfrequently rests upon the corneal margin, where, of course, it cannot insert. If the advanced piece should encroach far on the cornea, it may be divided by a cut into two halves, as I have done for years, and both halves will then lie at the corneal margin. Generally the advanced muscle retracts enough to furnish a more favorable insertion. After the sutures are tied, the eyes are irrigated with an aseptic solution and both are bandaged. In convergent squint the effect of the operation is increased by paralysis of accommodation. Therefore atropin is instilled into both eyes as long as there is any tendency to convergence. Exclusion of light, rest, and occlusion of the eyes have the same effect. The binocular bandage remains at least five days, for the healing of the wound. In convergent squint it is reapplied for several days more for the above reasons. Then it is replaced by correcting convex glasses. The sutures need hardly ever be removed before the sixth or seventh day. In divergent squint, accommodation and convergence assist the operation. As soon as the advanced muscles are firmly attached, one eye is left free. After one or two weeks the methodical exercise of convergence may be commenced."

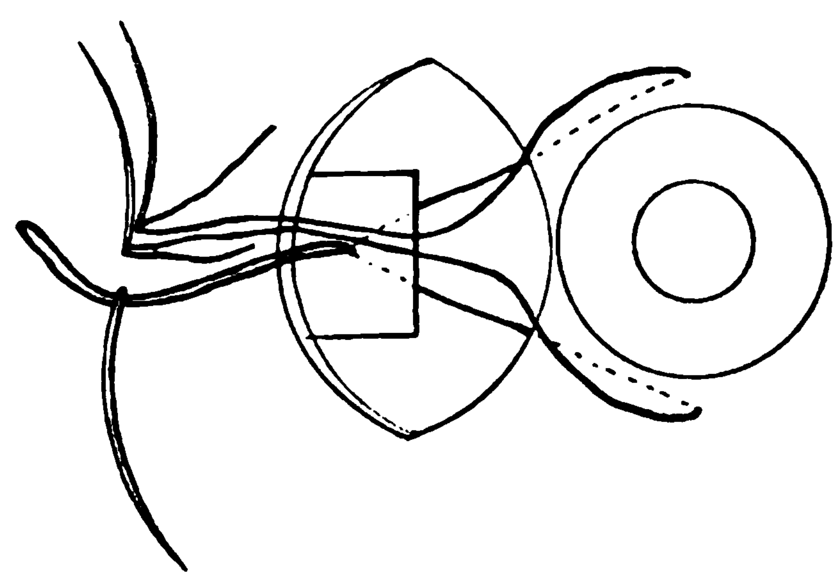


FIG. 68.—Weber's single suture operation.

The father of the single-suture advancement was Adolf Weber,[1] of Darmstadt, who, in 1873, contrived an ingenious though impracticable procedure (Fig. 68). After uncovering, picking up, and dividing

[1] Lit. Verzeichniss, No. 6, p. 415.

the tendon as did Critchett, he used a triple-armed suture that was threaded and inserted in the following manner: A fine, curved needle was put on at each end in the ordinary way, but at the middle the thread was doubled upon itself and passed thus through the eye of a somewhat larger needle. While an assistant lifted the tendon, the middle needle was passed through the center of the tendon from the scleral side, thence, also from within outward, through the distal conjunctival flap, the loop pulled through, and the needle removed. The other two needles were carried forward beneath the conjunctiva, one above, the other below the cornea, and brought out near the vertical meridian. They were then carried back and passed through the loop from the corneal side. The assistant then released the tendon from the forceps and the muscle was drawn up by the traction on the two ends of thread held together. When the muscle had been brought forward sufficiently the two threads were made into a rather large knot close against the loop so that the suture could not slip.[1] This measure possesses three points of great merit, in that it is simple, easy of execution, and, best of all, the tendon is drawn forward exactly in the horizontal meridian. Unfortunately, it has two fatal faults, viz., the thread, although double, traverses the thickness of the tendon at only one place, in consequence of which not only is it more likely to cut out, but, moreover, the center of the tendon is pulled forward in a point, while the lateral portions are thrown toward each other in plaits—not spread out as it should be.

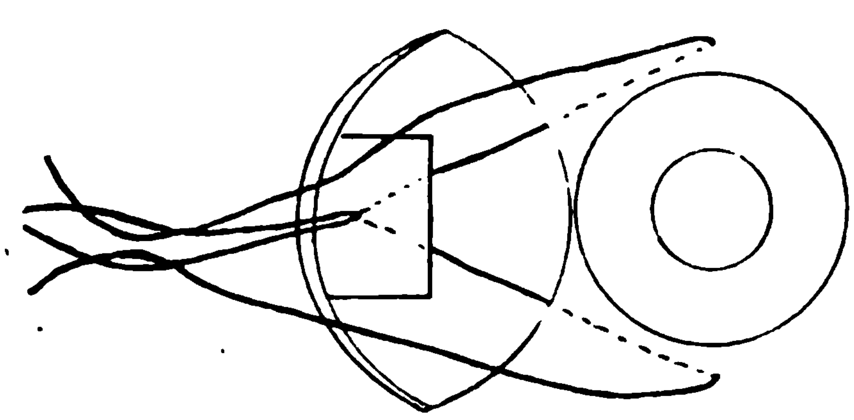


FIG. 69.—DeWecker's modification of above.

DeWecker[2] for a time practised a modification of Weber's operation (Fig. 69). Instead of holding the tendon by fixation forceps he, of course, used his own double advancement hook. The real change, however, consisted in the curious mode of disposing of

[1] Haab, in his "Augenoperationen," *Munich*, 1904, mentions having seen Horner make the Weber advancement save that, instead of putting both ends of thread through the loop from the corneal side, he passed one end from either side and tied them so as to include the loop in the knot.

[2] Ann. d'oculist, t. 70, 1873, 225.

the thread. The loop was drawn far through and cut. Thus there were two threads which the surgeon proceeded to tie—not each end to its fellow, but each to the opposite end of the other thread.

It will be seen by the foregoing descriptions that the thread finds its anchorage above and below the cornea save in the Critchett operation, where there is, in addition, a thread anchored between the cut end of the tendon and the cornea. There is another class of advancement methods wherein the *only* hold of the suture (or sutures), outside of that in the tendon, is between the latter and the cornea. A few of the more prominent of these will be described.

The Pulley Operation of Prince.[1]—This is a procedure which, modified by its author at certain stages of its existence, has stood the test of nearly a quarter of a century, and is both efficient and original (Fig. 70). Its early name, however, is hardly applicable to its present form. As he first made the operation, and as I had the pleasure of seeing him perform it in 1884 while on a visit to Dr. Agnew at the Manhattan Eye and Ear Hospital, N. Y., while I was house surgeon to that institution, was thus: A vertical thread was put firmly in the episcleral tissue close up to the cornea on the side next the tendon to be advanced —quilted in for a distance of about 6 mm., and the ends, for the moment, left hanging free. He then exposed the tendon, clamped it with his advancement forceps, and severed it close to the sclera. While an assistant held the forceps, a double-armed thread was passed, from within outward, through the tendon, thus leaving a loop in its under side. Then, while the aid drew the tendon forward, one end of the double-armed thread was laid at right angles across the buried thread at the corneal margin and the latter was tied snugly over it. In this way was formed the *pulley*. Lastly, the two ends of the other thread were knotted and drawn taut, advancing the tendon. In order the more readily to distinguish the threads the vertical one, or pulley, was white, the other black. The yielding of the outside portion of the pulley

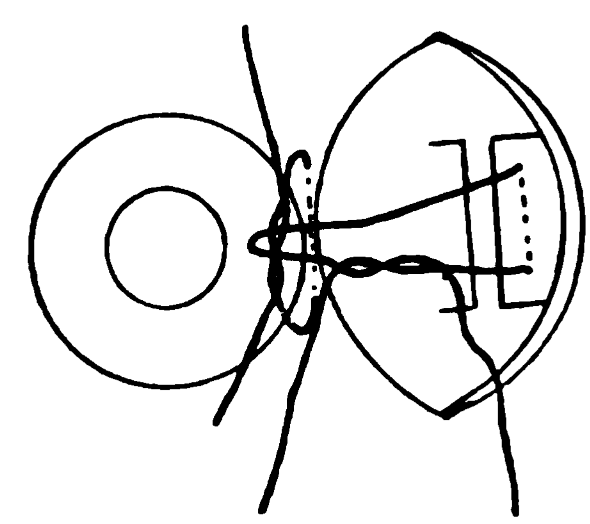


FIG. 70.—Prince's first, or "pulley" operation.

[1] St. Louis Med. and Surg. Journal, 1881.

and the bunching of the tendon into a cone, seeing that the traction was all from a single point, after a number of years, caused the author of the measure to very materially change and improve the method (Fig. 71). The pulley thread was omitted, and what had been the second stage of the operation, i.e., the exposing and picking up of the tendon, became the first. The double-armed thread was put into the tendon as before, whereupon one of the needles was made to traverse the tissue alongside the cornea, as had the old pulley needle, all that was left to do being to knot and draw the thread until the desired turning of the globe was achieved.

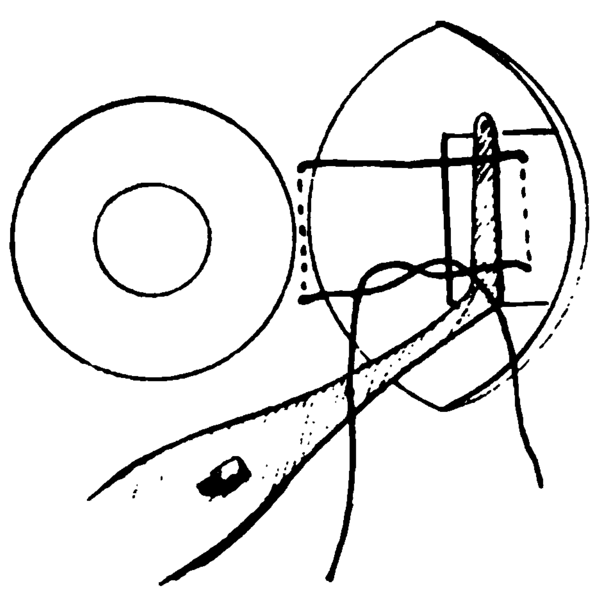


FIG. 71 —Prince's second operation.

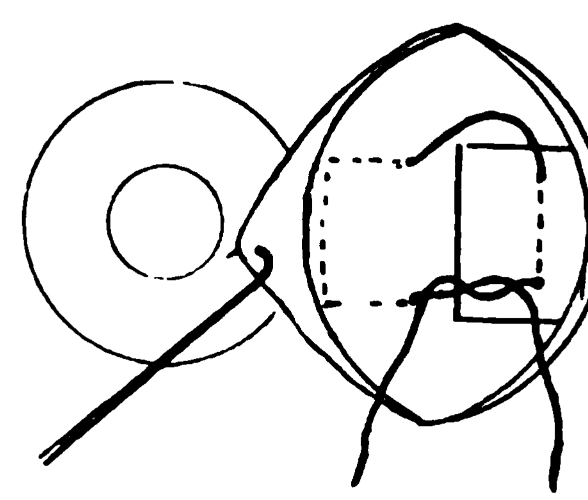


FIG. 72 —Verhoeff's advancement operation.

Verhoeff,[1] of Boston, has devised a one-suture mode similar, in most respects, to that of Prince, but with one essential difference. This has reference to the fastening of the tendon to the sclera. In the Prince operation the pull of the two threads is straight toward the cut end of the tendon, whereas, in that of Verhoeff, the greater portion of the tendon's width is tied down tightly to the underlying tissue—strapped down, as it were (Fig. 72). The procedure is thus described: A vertical incision is made in the conjunctiva, about 3 1/2 mm. from the cornea, and that membrane undermined up to the limbus. The tendon is exposed, lifted and held with the Prince advancement forceps. The flap of conjunctiva next to the cornea is retracted, one needle of a double-armed fine thread is passed, vertically, for a distance of 6 to 8 mm. through the episcleral tissue, one mm. from the cornea. At its point of exit the needle is again plowed for a short distance horizontally toward the tendon. The lower needle is

[1] Oph. Record, 1901.

made now to take this same horizontal course. Both needles are then passed through the tendon, from the scleral side, at a greater or lesser distance behind the forceps, according as much or little effect is needed. The assistant pulls the muscle forward the requisite distance and the thread is drawn up and tied. That portion of the tendon contained in the bite of the forceps is cut off, the free end placed beneath the conjunctiva, and the wound in this membrane closed by a fine suture. The conjunctival thread is removed on the fourth day; that in the tendon on the eighth. With proper needles and deftness, a very solid support can be got for the suture in this anchorage, representing, as it does, three sides of a rectangle, and for the lower degrees of squint it must be an excellent procedure. For the higher degrees, one would suppose it necessitates considerable resection of tendon; *ergo,* shortening of the muscle.

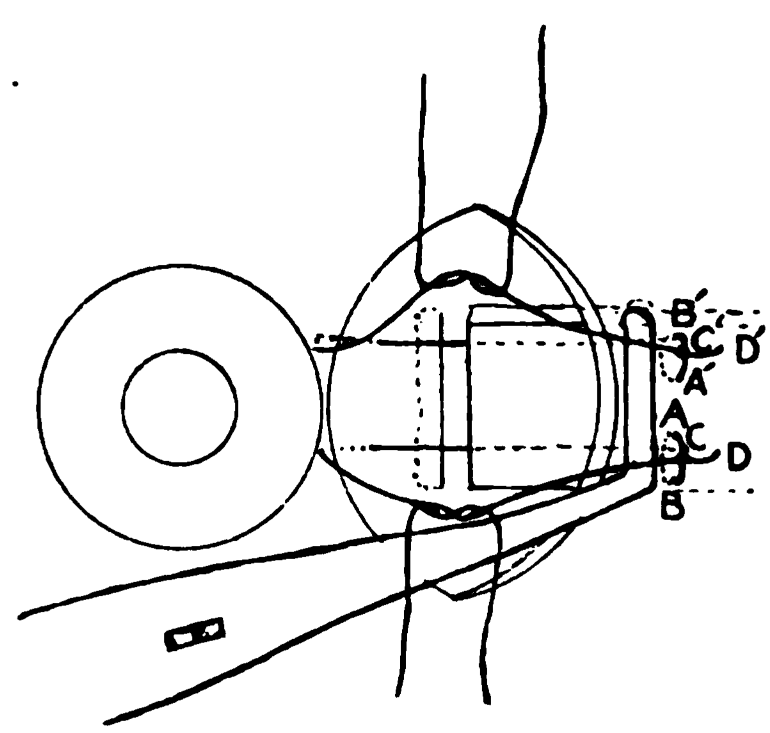


FIG. 73.—Worth's advancement operation.

In this class belongs also the operation of Worth.[1] This surgeon proceeds as follows: A vertical incision about 1/2 in. long is made through conjunctiva and Tenon's capsule, its middle close to the corneal margin. These membranes are retracted to expose the tendon. If the angle of the squint is of high degree, the incision is made curved, with its convexity toward the cornea, in order to allow the membranes to retract more freely. Prince's advancement forceps is introduced, with the toothed blade lying on the conjunctiva, and thus closed. The tendon and its underlying attachments are divided with scissors close to the sclera. Two needles, each threaded with a double strand of tolerably thick thread that has been previously boiled to remove the extra coloring matter, then steeped in a sterilized mixture consisting of three parts of white beeswax and five parts of white vaselin, are employed. While an assistant holds up the tendon and superposed membranes, one of the needles is passed inward at A (Fig. 73), through conjunctiva,

[1] "Squint," London, 1903.

capsule, and muscle, and brought out at the under side of the tendon. It is again passed through muscle, capsule and conjunctiva, and brought out at B. The bite of the thread thus encloses about the lower fourth of the muscle with its tendinous expansion, capsule, and conjunctiva. The other needle is similarly entered at A′, passed through conjunctiva, capsule, and tendon, and brought out at the under side. It is then again entered beneath the tendon and brought out through the conjunctiva at B′, this bite enclosing the upper fourth of the tendon. Both sutures are inserted, before proceeding further, in order that they may be symmetrically placed. The ends of the thread from A′ and B′ are then knotted tightly at C. The end bearing the needle is then entered at D, passed through conjunctiva, capsule, and tendon, and carried beneath the lower blade of the Prince forceps nearly to the corneal margin. The needle is here passed through the tough circumcorneal fibrous tissue and brought out at G′. The two ends of thread are then loosely tied, with a single hitch, at H. The first suture is then similarly completed. The anterior part of the tendon, capsule, and conjunctiva are then removed by the scissors just behind where they are grasped by the forceps. The gap is then closed by tightly tying each suture at H H, so that the cut end of the tendon is brought nearly up to the corneal margin at G G′. The longitudinal position on the muscle of the knotted loops A, B and C, and A′, B′, and C′ varies according to the degree of rotation desired.

The hold on the tendon in this operation afforded by the knotted arrangement of the sutures insures extraordinary solidity, but it is a question whether or not a certain amount of necrosis would not ensue from strangulation. As for the rest, the anchorage near the cornea, which is of even greater importance, is relatively slight—much more so than in either the Prince or the Verhoeff operations. Moreover, the operation would seem to be needlessly complex.

The Beard Advancement Operation (Figs. 74 and 75).—The first published account of this procedure appeared in the *American Journal of Ophthalmology* for March, 1889. Within the past three or four years several articles in the ophthalmic literature of Great Britain and the continent of Europe have been brought to my notice, in which the writers told of original methods very similar to, and

in one case—viz., Dr. H. Lindo Ferguson[1]—practically identical with this, though it is a pleasant reflection that they all lack priority.

In most instances the first part of the operation consists in the making of the neatest possible buttonhole, as per description on page 164 of the tendon of the muscle opposite to that which is to be advanced. The sole object of this partial tenotomy is to cause a temporary breaking of the power of that muscle, so that the advanced tendon may have a relatively undisturbed period during which to make its new insertion. The tiny scissors and hooks of Dr. Stevens, of New York, are employed.

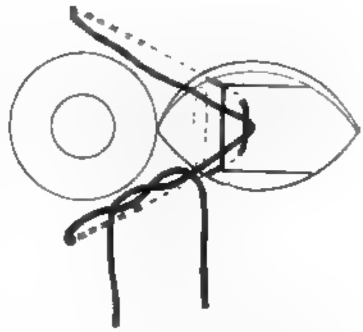


FIG. 74. Beard's advancement operation. The tiny dotted oval is to represent spot where tendon was attached. The double dotted line shows where thread is anchored to sclera. The tendon is never laid bare as this drawing would indicate.

The patient is told to look far to the opposite side; with mouse-tooth forceps the conjunctiva, and only this membrane, is picked up in a vertical fold, well back of the insertion of the muscle; with small, straight scissors, slightly blunted at the points, a snip is made across the fold, exactly over the center of the tendon, and the incision thus begun is carried forward horizontally till it reaches the margin of the cornea. Then the episcleral tissue forward of the insertion of the tendon, if there be enough of it, is in like manner incised, so that a furrow is opened, whose bottom is the naked sclera, and along which the cut tendon is to slide. By so doing, one reaches the tendon by positive stages, neatly and discriminately, and avoids giving it an unguarded snip, which is possible with too heroic cutting. The tendon, lightly covered by its aponeurosis,[2] being now well in view, is slightly lifted by the forceps, and a medium-size squint-hook inserted beneath it, as close as can be to the insertion. No advancement force s is put on to mangle the tendon—an assistant holding the hook until the suture is placed.

[1] Transactions of the Ophthalmic Society of the United Kingdom, vol. xvii, p. 336.

[2] In striving for marked effect one must be careful to avoid undue advancement of Tenon's capsule. This means tightening of the check ligament on that side and consequent restriction of motility.

This last is of No. 1 braided black silk, boiled in equal parts of paraffin and vaselin, and is double armed—i.e., has a needle at each end. The needles are as fine as will barely carry the thread, and are straight two thirds of the way from eye to point, from thence slightly curved. As a necessary precaution, the needles should be tested to see that they are quite sharp, and their points be examined under a magnifying glass to make sure that they are without flaws.

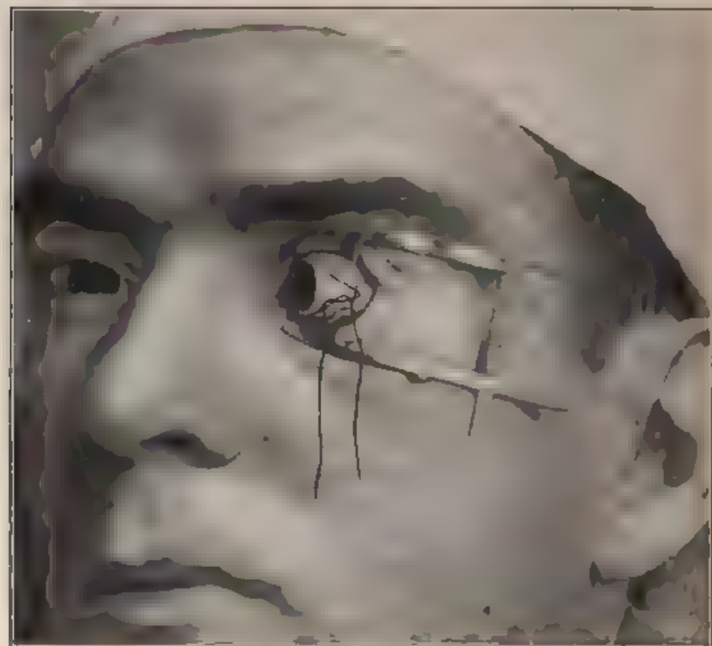


FIG. 75

Both needles are passed downward through the tendon (see Fig. 74), at a distance from its insertion proportionate to the degree of effect desired, one near the upper, the other near the lower border, and the loop or stitch thus formed is drawn down snugly upon the tendon. Then, taking the upper needle in the holder, the conjunctiva and anterior capsule are lifted by the forceps, and the needle passed beneath these membranes without entering them, carried well forward, then plunged into the episcleral and superficially into the scleral tissues, and plowed along until a point is

reached opposite the vertical meridian of the cornea, or beyond, and fully four to five millimeters from the limbus, where the needle is brought out. The lines of anchorage should be divergent, not horizontal. Merely placing the suture beneath the membranous covering of the globe will not suffice; a much firmer support is required. Notwithstanding the sharpness of the needles, no little exertion is needed to force them through the dense fibrous tissue, and in doing so the globe must be steadied. To grasp the conjunctiva and capsule, to this end, will not do, as these membranes will tear; so I take hold with strong broad-jawed forceps of the tendon at its insertion, even including the hook as held by the assistant. Precisely the same is done by the other needle below. Now, obviously, if the ends of the thread were here tied, the suture would lie across the cornea; instead, however, the upper needle is again placed in the holder and passed from behind, under the loop or stitch that lies vertically on the tendon (see Fig. 74), and one must be quite sure that the needle passes *under* the thread, and not *through*, even the least strand or fibre of it; for this would cause a snarl in drawing up the suture, and do away with one great feature of this operation—that of a perfect sliding suture. To make sure, we had better include a little of the tendon here, or else leave the loop standing up a little, so that we may see clearly what we are doing. It is better to make an invariable rule of using the upper thread for this step—as, in the first place, the knot does not lie beneath the sensitive upper lid, and, in the second, the removal of the suture is made simpler and easier. One now proceeds to divide the tendon. The thread is gotten out of the way of the scissors; if need be, held out of the way by an assistant with a strabismus hook; for to cut it in two were awkward in the extreme. The hook beneath the tendon is taken by the operator, and the tendon is completely severed; next, the stump of tendon at its insertion is seized by the forceps and cut off even with the sclera. The latter step serves two very important purposes—it removes an obstacle to the sliding forward of the tendon, and prevents an unsightly lump at the site of the operation. Then, as to the tying and tightening of the suture, several points must be observed. One should have his assistant rotate the eye toward the operated muscle by means of fixation forceps. It is essential that the loop across the tendon

should remain tightly drawn down; to insure this, and at the same time obviate any tearing up of the track of the suture where it lies deeply imbedded under the conjunctiva, take hold of the upper end of thread with the dressing forceps, and the lower one with the fingers, just where it emerges above and below the cornea, and pull, not back in the direction of the advancing muscle, but away from it (in Fig. 75, toward the nose). This insures drawing the muscle forward in a straight line. Having in this way drawn the muscle well forward, the assistant "takes up the slack" of the end of the thread which passes beneath the loop, gives it to the operator, who lets go with his dressing forceps, and ties the suture.

The tension being equal on all the thread-bearings, the advancing tendon is drawn neither up nor down, but comes forward in a straight horizontal line. One may leave the suture tied in a long bow-knot, after Prince, the shorter end of the thread being always the one which controls the loop, so that after the lapse of twenty-four hours, if, for any reason, there is occasion for modifying the effect upon the eye, the last part of the knot may be untied, and the suture either tightened or slackened, as desired; and in any but dispensary practice this will do excellently. On first removing the bandage, whether one wishes to shift the suture or not, the long ends and loop of thread, which have been till now fixed by the dressing just outside the nearest canthus, are, before rebandaging, cut off close to the knot. The suture is allowed to remain in the eye from six to nine days—the dressing being renewed during the time at intervals of about forty-eight hours. Both eyes should be bandaged, and absolute rest in bed for at least forty-eight hours must be insisted upon.

I have abundantly proven that the pull of the suture in the tendon is not only to move and hold the muscle forward, but also to keep the tendon spread out flat. This is easily demonstrated by a model —even with the flimsiest material to represent the tendon.

Some few of my confrères, on reading as to the technic of the advancement operation herein detailed, have conceived a notion that it is complicated and difficult. This impression has doubtless arisen from my having dwelt at such length upon the minutiæ of the operation, which alone insure success. As a matter of fact, it is one of the simplest of procedures. It is, moreover, one of the

safest. There is usually some superficial reaction, but in all my experience I have seen but a single case which promised trouble. This was that of a dispensary patient, who reported on the fourth day after the operation with septic tenonitis at the site of the incision. The process was promptly arrested before any damage resulted. My experience with the operation refers to a great number of cases, many of which I have had under observation for from five to twenty years, and I can affirm that the results have been most gratifying, both to patients and to operators. I would, therefore, confidently and heartily recommend it to the profession. The day of the tenotomy, pure and simple, as a rational remedy for the cure of strabismus is past. Its mangled victims have too long paraded their horrors, such as the paralyzed muscle, the secondary squint, the retracted caruncle, and the ghastly exophthalmos.

3. **Capsular Advancement.**—In the hope of doing away with the annoyance caused by the cutting out of the thread and the escape of the muscle in the advancement operation, at a time when it was the custom to completely denude the tendon, DeWecker[1] proposed his *advancement capsulaire*, which, even at the hands of its inventor, enjoyed but an ephemeral existence. The idea was that, by advancing the adjacent check ligament or, in the plural, as the French put it, *les ailerons capsulaires*, or lateral capsular expansions of the tendon, the muscle would be supported and strengthened, and the end would be accomplished without touching the tendon. Here is how he proceeded: First, the excision of a semilunar or pyramidal-shaped piece of conjunctiva, base toward the cornea, over the insertion of the tendon, about 10 mm. high and 5 wide, and a corresponding portion of Tenon's capsule; then detached the tendon from its capsular sheath all around, undermined the conjunctiva up to and around the neighboring half of the cornea, and, lastly, drew the capsule forward and secured it by two sutures arranged much as are the outer threads in the Critchett advancement, the difference being that the tendon was left untouched, as it was not expected to move, but merely to allow the capsule to slip forward over it. The effect was dosed by the dimensions given to the excised portions and the size of the bite of the thread in the capsule. DeWecker practised making of this operation for several years. The

[1] Annal d'oculist, t. xc, p. 188, 1883.

writer saw much of this gifted surgeon's work in the years 1885 and 1886, during which time he met Herman Knapp, who made a long visit to Paris in the latter year. Knapp became impressed by DeWecker's enthusiasm over the measure and, on returning to New York, "made the operation a few times. The effect proving insufficient, I at once modified it in such a way that it was in reality a tendino-capsular advancement."[1] Knapp told of his modification at the meeting of the American Ophthalmological Society in 1886, and the first published account of it appeared in the transactions of this society for that year. DeWecker very soon abandoned the original operation and adopted what is practically Knapp's modification (Fig. 76). Here is Knapp's description of it in Norris and Oliver's system, page 876: "The conjunctiva is vertically incised over the insertion of the tendon, and undermined around the cornea to the vertical meridian; Tenon's capsule opened with the scissors at the lower line of the insertion line of the tendon, a strabismus hook slipped beneath the tendon and the capsule incised over the tip of the hook on the upper side of the tendon. Three or four sutures are applied, one through the conjunctiva and the lower edge of the muscle, passing under the conjunctiva obliquely forward, then two or three millimeters through the outer layers of the sclera immediately before emerging on the conjunctiva near the vertical meridian. The second suture is on the upper side, and pursues a course analogous to the first. The third suture is passed through the conjunctiva and the middle of the muscle, advanced *under* the hook, which during the application of all the sutures raises the tendon, thrust through the middle of the tendon near its insertion, then through the superficial layers of the sclerotic to emerge on the conjunctiva near the cornea. If a large effect is desired, a fourth suture is applied at the side of, and similar to, the third. The sutures are tied in the same way as

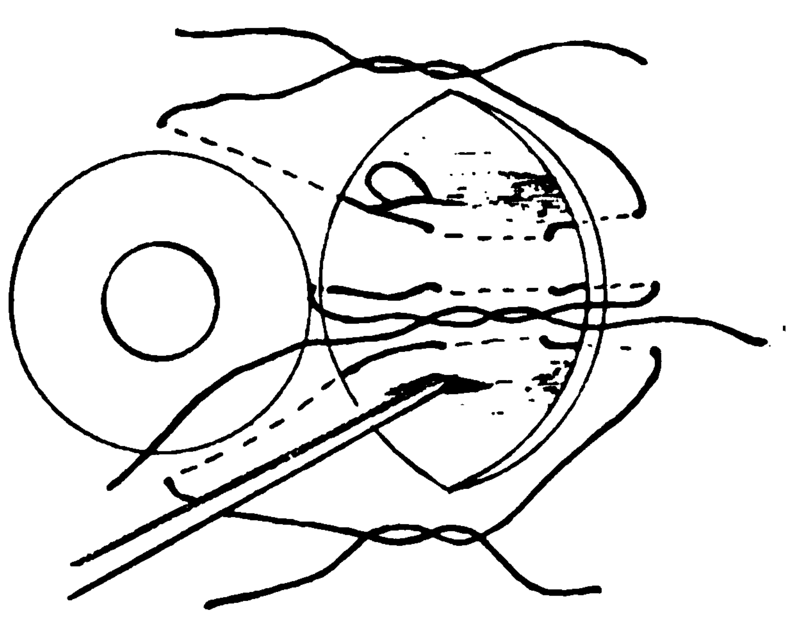


FIG 76.—Knapp's musculo-capsular advancement.

[1]Quoted from Knapp in Norris and Oliver, p. 876.

in Critchett's advancement. The operation, in fact, is the same as Critchett's without excision of a piece of tendon. The sutures remain in five or six days. The operation acts by shortening (tightening) the check-ligaments and the muscle *by folding them.* They remain folded and attached to their new position on the sclerotic by means of cicatricial tissue, which is formed by an adhesive inflammation due to the irritation set up by the sutures."

4. **Tendon shortening,** for the cure of the various forms of squint has been, and still is, extensively practised. As has been stated, this is accomplished in two ways: (*a*) by folding of the tendon upon itself and fixing it so, or tucking; and (*b*) by the excision of a portion of the tendon—*tenonectomy.*

a. **Folding or tucking** of the tendon is the outgrowth of DeWecker's capsular advancement, treated of in the preceding section, and, as there asserted, it was Herman Knapp, of New York, who was the originator of the measure under the name of *tendino-capsular advancement.*

Kalt[1] proposed a modification of Knapp's method, which consisted in omitting the tendon from the thread, but putting it in capsule only, as did DeWecker in his capsular advancement. The sheath of the tendon was not loosened, but *to avoid folding the tendon* he severed the latter from the globe and allowed it to advance with the capsule.

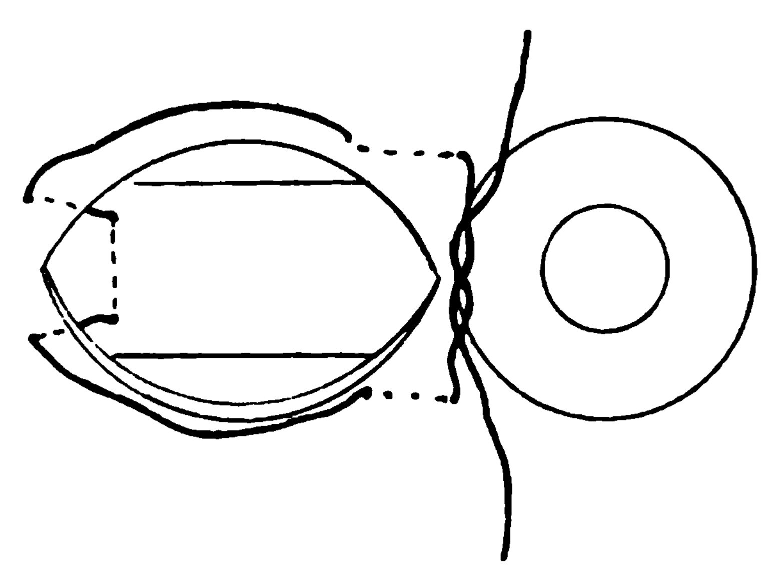


FIG. 77.—Lagleyze's folding method.

Lagleyze,[2] of Buenos Ayres, reports excellent results obtained with a folding operation of his own, (Fig. 77.) made as follows: After having excised a flap of conjunctiva overlying the tendon, he incises Tenon's capsule, inserts one strabismus hook beneath the tendon and another beneath the fleshy part of the muscle. He then proceeds to suture by means of a double-armed thread. One needle is made to pass through the body of the muscle from its scleral surface, 1 mm. from its border and, in emerging, to include the capsule and con-

[1] Soc. d'opht., 2 mars, 1891.
[2] Arch. d'opht., xii, p. 668, 1892.

junctiva; the other needle follows the same course near the other border. The loop of thread thus rests on the fleshy portion of the muscle. The needles are then carried forward and the ends of thread given secure anchorages near the cornea. In proportion as the thread is drawn up, the strabismus diminishes. The thread is removed at the end of 12 days. Obviously, this operation can be made applicable only to the lower degrees of squint.

So numerous have been the original folding, or tucking, operations that have been given to the world since those just mentioned, and, as only a somewhat elaborate or detailed description in each instance could give an adequate idea of its merits—and merit they have, almost without exception—it is inexpedient to more than refer to some of them here.

Colburn,[1] of Chicago, some twelve years ago gave what he called an "advancing tuck operation."

Savage,[2] of Nashville, devised a muscle-tucking operation more than ten years ago. Again,[3] about one year ago the same surgeon published another tendon-folding measure.

It seems that a classification of these procedures is made into the "shortening tuck," i.e., where the fold is made at or behind the insertion of the tendon; and the "advancing tuck" where the same is formed between the insertion and the cornea.

Todd,[4] of Minneapolis, and Clark, of Columbus, have not only given tucking operations, but each has invented an ingenious tucking instrument. Todd's is a kind of two-tined fork, or bident, one prong of which is placed beneath the tendon and there clamped by turning a nut on the handle—to rotate the instrument backward makes the shortening tuck, and forward, the advancing tuck (Plate VII, No. 87). The Clark device is a triple squint hook, the middle member of which is made to move up or down by turning a knob on the handle. When the three members are on the same level, the instrument appears only as a rather broad hook. To apply it, the middle portion is placed somewhat below the other two, introduced beneath the tendon, while the other two rest on top of the tendon.

[1] Oph. Record, April, 1902.
[2] Oph. Record, March, 1893.
[3] Oph. Record, Nov., 1903.
[4] Oph. Record, vol. xi, p. 73, 1902, and Annals of Oph., Oct., 1904; also Journal Am. Med. Assn., Jan. 7, 1905.

The middle is then made to rise, whereby a fold of the desired height is formed. In each case the folds of tendon are sewn together by animal sutures to prevent unrolling.

Bruns,[1] of New Orleans, is also the author of a clever folding operation, and has contrived a modification of the Clark hook to meet the requirements of the proceeding.

A truly cavalier folding operation is that of Trousseau.[2] Given a convergent squint, for example, after moderate tenotomy of the internus, an aid rotates the globe far inward, the tendon of the externus is grasped by fixation forceps and drawn away from the globe. A long, curved needle and substantial thread are passed into the episcleral tissues near the cornea, through the tendon, then beneath the body of the muscle, finally through it and out. The eye is then rotated to the outer angle and the suture tied. The thread remains from 6 to 12 days. In 27 cases the results were satisfactory in 21.

Other European originators of folding operations are Brand[3] and Foster.[4] The latter's is very like the Schweigger resection operation in all save that, of course, the tendon is not divided.

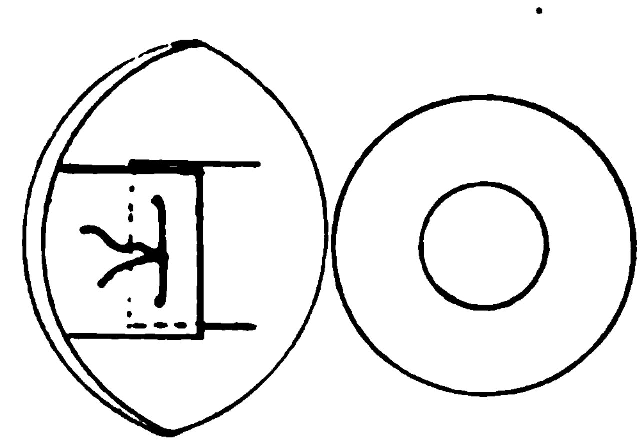


FIG. 78.—J F. Noyes' shortening.

There is one feature wherein the folding methods are unique—if they do not succeed in correcting the deviation, they cannot leave it greater than it had been before.

The strabismus operation of J. F. Noyes,[5] of Detroit, has been referred to as a folding operation (Fig. 78). It was, in truth, a shortening operation—not, however, by folding nor by resection of the tendon, but by dividing and lapping it. The whole width of the tendon was cut through at a distance from its insertion that varied in accordance with the degree of squint; the distal end was placed beneath the stump, and the two sewed together.

b. **Shortening by excision of a part of the tendon—resection—**

[1] Oph. Record, June, 1904.
[2] Annal d'oculistique, Jan., 1903.
[3] A. F. A., 1902.
[4] Versammlung. der Niederl. Ophthl. Gesellsch., Dec., 1901.
[5] Trans. of the Am. Oph. Society, 1874, p. 273.

tenonectomy—as an adjunct to the rest of the procedure has been employed, in some measure, by almost every ophthalmic surgeon who ever made a veritable advancement operation, but as a single measure it has not been given wide application. For my part, I believe it to be a measure that deserves more consideration in the professional mind than it enjoys—in this country, at least. Surely, it is as much to be commended as is the operation of tendon folding. Yet were its popularity commensurate with the number of different modes that have been proposed for the performance of it, its place in ophthalmology were assured. On the continent of Europe resection does not go abegging.

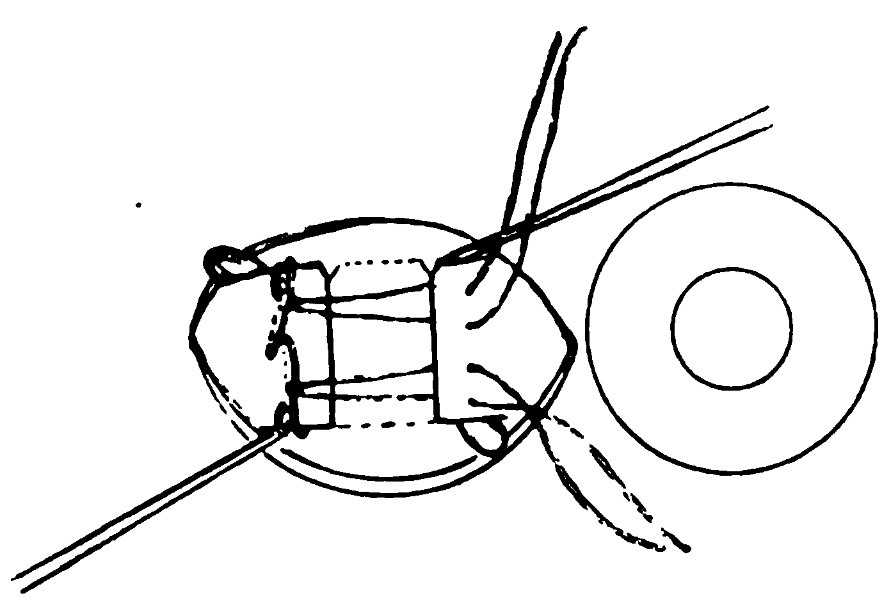


FIG. 79.—Schweigger's resection operation for squint.

One of the first to give prominence to such muscle shortening was Vieusse,[1] who cut the tendon a short distance behind its insertion, abscised from the posterior portion what was requisite for the case, and united the cut ends by two sutures.

Probably the most extensively practised of any resection to date is that of Schweigger[2] (Fig. 79). After tenotomy of the opposite muscle a horizontal incision is made through conjunctiva and capsule, over the center of the tendon to be excised. A flat, curved hook is inserted beneath the tendon and shoved back and forth to free and spread it out. A second hook is then inserted, but from the opposite side. While one hook is pushed up snug against the insertion, the other is pushed backward till from 8 to 10 mm. of the tendon are exposed. With the help of an aid, the amount of tendon to be resected is measured off with a tiny tape, something like a strabometer—also Schweigger's invention—bearing a mm. scale whose zero is in the center, and the points marked by slight nicks in the edge of the tendon. Two double-armed catgut sutures are ready. These are put in, one or two mm. back of the posterior nick; the

[1] Record d'opht., 1875, p. 330.
[2] A. F. A., 29, p. 165, 1894.

needle of one suture is drawn through close to the upper border, carried beneath to a point slightly below the center, then up through. Now, a needle of the second thread is drawn through near the lower border, carried up under, and out just above the center. Each suture is tied, thus ligating the entire tendon. The four threads are held by an assistant, the tendon is cut at the posterior nick, the stump is lifted by forceps, the four needles passed through it from the scleral side, close up to the insertion, the tendon is cut off at the other nick, thus completing the resection, the sutures are drawn so as to butt one end of tendon against the other, and tied. The outer wound is closed with silk thread.

Another such shortening measure is the "Myectomy" of L. Müller, the main points of which are thus: The operation is made under narcosis to relax the muscle. Bilateral tenotomy of the *Shiel-muskel.* Vertical incision of conjunctiva 4 mm. from the cornea, and the wound well retracted to lay bare the tendon. The latter was lifted on the hook at a distance behind the insertion corresponding to the length of the piece to be excised, which, in divergent squint, this surgeon states, would be from 6 to 8 mm., and for convergent, somewhat less The proposed section is so measured on the tendon by means of small compasses, and so marked as to leave a 2 mm. stump at the insertion. Close behind the piece to be resected are placed the sutures of rather coarse silk, one near the upper, the other near the lower border, each including about 1/4 of the width of the tendon, and tied. The ends bearing the needles are cut off close to the knots. While an aid holds the threads, the tendon is cut at the distal mark, and two other silk threads are put into the stump close to the sclera and in the same way as were the other two, cutting off the needle ends. The tendon is now cut at the proximal mark and the opposite ends of the thread are tied in surgeons' knots, at the same time approximating the ends of tendon. The outer wound is closed by five sutures, and the buried threads are left in for all time.

In comparing resection with advancement, Müller affirms that the latter finds no analogue in surgery, and is a very imperfect procedure, for the reason that one does not know how much the yielding *conjunctiva* will, during the first 24 hours, permit the muscle to retract. Consequently, one must always aim for a primary

over-effect without knowing how much of it will disappear. Moreover, he believes it of the greatest importance that the original point of insertion be left intact, to prevent an oblique attachment, which could occur through sliding about of the advanced tendon.

It is evident that the foregoing remarks do not refer to that form of advancement in which a solid anchorage is obtained for the thread in episcleral or in scleral tissue.

The Beard Shortening Operation.—Fig 80 illustrates an operation devised by the author[1] some time ago, which is adapted to certain cases where shortening of the muscle, and not advancement, is desired; though I must admit I have rarely found occasion to practise it. The tendon of the opposite muscle is buttonholed, as if for the advancement operation. Here also the suture is a double-armed one, the needles being of a half-curved variety and very sharp. The primary incision is the same as in the advancement, though here the tendon is laid bare. In this operation the advancement forceps must be used. This instrument fixes the tendon midway of the parallelogram included between the vertical lines (Fig. 80), which, of course, varies in length according to the degree of shortening needed. The tendon is then divided at the point occupied by the line near the cornea, and the forceps given to an assistant. Catching hold of the stump of tendon with mouse toothed forceps, the needles are passed down through the insertion, hugging the sclera, one near the upper, the other near the lower border. They are then carried beneath the tendon, without crossing the thread, and brought out correspondingly from below, and far enough back of the fixing forceps to insure a firm hold; the loop, however, is not drawn down, but is left very long, as shown in the drawing. Here the operator takes the forceps from the assistant and cuts the

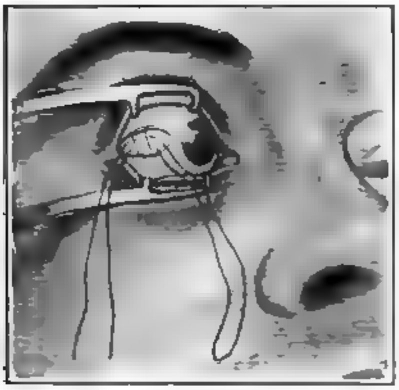


Fig. 80.

[1] American Journal of Ophthalmology, March, 1889.

tendon at the point indicated by the other vertical line, thus resecting a portion. The long loop and the two ends of thread are then tied in one knot, and the cut ends of the tendon nicely butted together. If the surgeon prefers, the loop may be cut and the ends tied separately. The thread may be absorbable or not, as the operator chooses. The wound in the membranes is closed by one or two fine sutures. The points claimed for this over certain other shortening operations lie in the facts that the thread embraces and supports the united ends of the tendon, both in front and behind, so that they are kept in nice apposition, and not inclined to stand up in a pout, and that the operation is simple and easy of execution.

Among others who have designed practicable resection operations are Driver,[1] Coates,[2] Baraquez,[3] Prince,[4] and Stevens.[5]

5. **Tendon Recession.**—In the writer's opinion, there is but one class of squint cases wherein the surgical treatment calls for an actual setting back of the muscle toward which the eye deviates, viz., that in which the muscle is abnormally short. This is found in certain instances of congenital squint, and, exceptionally, in the case of middle-aged or elderly subjects with acquired squint in whom the defect has been of many years' duration. I refer particularly to those in which the length of the muscle is so inadequate that not only is the eye incapable of voluntary rotation in the opposite direction, but also refuses to so turn under fixation forceps, even with the subject in complete narcosis. The condition is exceedingly rare, the writer having encountered it not to exceed six or eight times in as many hundreds of operated cases. To attempt advancement of the antagonist without a recession of this short muscle would result in the production of an unwarrantable degree of exophthalmos, and still greater limitation in the motility of the globe. Indeed, advancement of the opposite muscle is not needful save in a certain percentage of these cases, the recession alone being sufficient. The ordinary complete tenotomy is not applicable because of the uncertainty as to what would ultimately become of the severed muscle. What is wanted is something that will limit the extent to which

[1] Kl. Mbl. f. Aug., p. 133, 1876.
[2] Lancet, May, 1878.
[3] Bolletin de Clin. oft. de Santa Cruz, No. 2, p. 17, 1885.
[4] Journal of the Am. Med. Assn., Oct. 13, 1888.
[5] N. Y. Med. Jour., p. 345, 1889.

the cut muscle will recede. This is found in a suture arranged after a given fashion. The first, to my knowledge, to use such a suture, was A. E. Prince, of Springfield, Ill., back in the early "eighties." I have not at hand this article on the subject nor do I recall the exact technic. Prince called it "tenotomy with a control suture." A little later, Colburn, of Chicago, made a similar tenotomy and named the thread "restrain suture." In the *American Journal of Ophthalmology* for March, 1889, the writer published his method of making the operation under the caption "curb tenotomy." It is substantially as follows: The tendon is exposed by a horizontal incision through conjunctiva and capsule, whose center is over the middle of the insertion. The tendon is caught upon a small flattish hook, which is shoved back to free the muscle from its sheath. A double-armed thread of No. 1 braided silk is put into the tendon 2 or 3 mm. behind the insertion by passing a needle down through close to each border, and the loop thus formed pulled down snug. The needles are then carried beneath Tenon's capsule, one above, the other below, just in line with the loop, given a good bite, and brought out through both capsule and conjunctiva. While the operator holds the thread, an aid rotates the eye far outward (it being the internus) in order to still further loosen the tendon from its surroundings; the globe is set free and the suture so tied as to leave a slight convergence. The same suture closed the opening in the membranes. Of course, the tendon does not reunite to the globe, but to its aponeurosis. In about half my cases all the gain was cosmetic; the rest showed increased motility in both lateral directions.

6. **Operations Upon the Check Ligaments.**—*Ailerons Capsulaires*, of the French, and *Bindenflügels* of the Germans. The studies of Motais, Kalt, and others have demonstrated that it is possible to enhance the power of an ocular muscle by judicious division of the adjacent check ligament, just as Landolt has shown that proper advancement of a lateral muscle may cause extension of the field of fixation in *both* directions. At a result of his researches Motais has given certain rules for such capsulotomy. Supposing an internal squint: Turn the eye outward, incise conjunctiva and the tissue beneath it from near the cornea to the center of the tendon, thence the mucosa along its whole length in front of the muscle.

Now feel along the outer surface of the capsule with closed, blunt scissors, and, back some 9 or 10 mm. (15 mm. if it were on the outer side) the instrument encounters a pretty firm resistance. This is the ligamentous expansion of the capsule. The scissors are opened, and this tissue is cut with short snips of the scissors.

The same writer also gives instructions how to proceed in case the ligament is to be cut in the middle of its course or at its union with the periosteum of the orbit. At the same time, he strongly cautions against attempts at these operations by those who are not thoroughly versed in the anatomy of the parts. He might also have added that, like the single operation of strabotomy, the final result is problematical. Moreover, the danger of orbital cellulitis must be ever present.

Parinaud[1] also gives a method for setting back the check ligament. Given a convergent squint, the eye is put in extreme abduction by forceps. A horizontal fold of conjunctiva is picked up over the insertion and cut athwart with the scissors so as to make a vertical incision 10 or 15 mm. long, and at the distance of about 7 mm. from the cornea. The conjunctiva is undermined back to the caruncle, the sheath of the tendon is exposed and the capsule cut along its upper borders. Through the opening thus made blunt scissors are thrust and the fascia is cut upward, curving a little backward, for a distance of 10 mm. The same is done below the muscle. The conjunctival wound is closed by suturing. A capsular advancement on the other side, and even tenotomy on the same side, may accompany the procedure.

In another place Parinaud[2] recommends setting back the capsule in every case of convergent squint when spontaneous lessening of the deviation, once begun, had ceased to progress; especially in those where the wearing of glasses had caused the defect only partially to disappear.

7. **Tendon Lengthening.**—Sidney Stephenson, of London, according to an article in *the Lancet* of September 23, 1905, was the originator of this class of squint operations. Realizing the extremely uncertain effect of simple tenotomy, it occurred to him that a more strictly scientific proceeding would be to lengthen the

[1] Note à l'acadamie des sc., 14 avril, 1890.
[2] Bull. et mém. de la soc. franc. d'opht., p. 291, 1893.

tendon of the rectus muscle without at the same time interfering with its actual insertion into the sclerotic coat of the eyeball. In this way he hoped that the dosage of tenotomy might be rendered more or less certain instead of being, as in the old operation, an almost unknown factor. He described the method of operating and exhibited several patients upon whom the operation had been performed, at the Ophthalmological Society of the United Kingdom in 1902. Briefly, the steps of the operation are as follows: A vertical or curvilinear incision is made with scissors over the insertion of the internal rectus muscle and the latter is exposed as fully as might be and carefully separated from the overlying conjunctiva by a few snips of the scissors. After a small squint-hook has been passed beneath the tendon a fine, well-boiled, silk suture is inserted through the lower border of the tendon close to the sclera. The lengthening of the tendon might be effected in several ways, of which the two most practical alone need be described: 1. (Fig. 81.) A long oblique incision is made with scissors, commencing at the lower border,

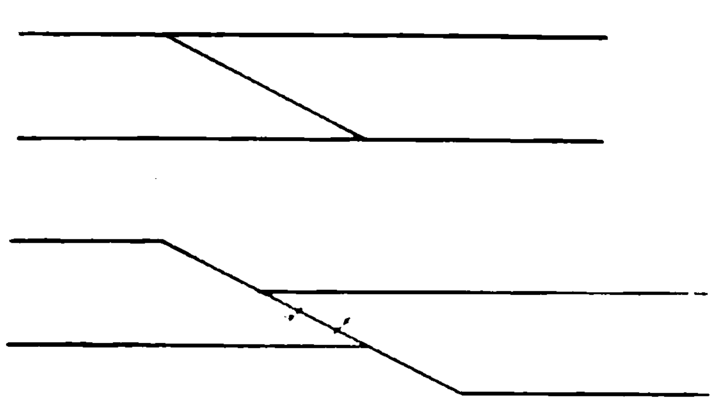


FIG. 81

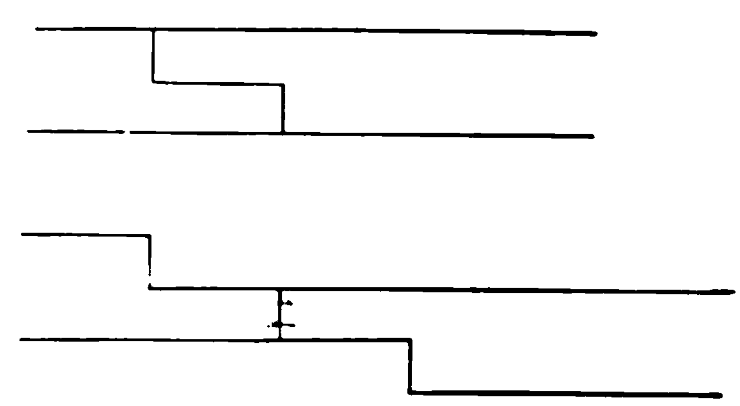


FIG. 82.

near the scleral insertion, and terminating at the upper border of the muscle some distance from its tendinous attachment to the eyeball. The two ends of the tendon are then united by a couple of points of interrupted suture. 2. (Fig. 82.) The lower half of the tendon is cut through some little distance from the scleral insertion and the incision is carried along the center of the tendon, midway between its upper and lower border, finally to be brought out at a right angle to its former course. The free ends left by this step-like incision are united by sutures. The lengthening of the tendon as carried out by either of the foregoing methods should be directly proportionate to the linear measurement of the squint; in other words, in a strabismus of five millimeters an attempt to lengthen the tendon by just

that amount should be made. The final step, after the tendon sutures have been tied and cut off short, is to close the conjunctival incision neatly with several points of interrupted suture. The operation of tendon lengthening may or may not be combined with tenectomy and advancement of the antagonist muscle. Stephenson remarks, in passing, that an agent has recently been placed at our disposal that acts even better in inducing local anesthesia and hemostasis in those cases than cocain and adrenalin applied separately to the eye. The new combination has received the name of "eusemin" and consists of cocain, adrenalin, and chloretone dissolved in physiologic salt solution. Applied to the eye before and during the performance of the operation, eusemin renders the work at once simpler and more speedy. He further says that the operation of muscle lengthening is by no means easy to do, but he is convinced that it is more exact and scientific than the ordinary tenotomy, and the results can be foreseen and graded with considerable accuracy.

The technical difficulties of tendon lengthening led the writer to find a simpler substitute and he made use of a device adopted by orthopedic surgeons—viz., the so-called "artificial tendon." This procedure is explained, and as applied to the internal rectus muscle is described as follows:

"The tendon is exposed as in the former case and two sterilized silk threads are passed through the tendon about three millimeters from its scleral insertion—one through the upper and the other through the lower border of the muscle. The threads are then knotted, one long end armed with a small curved needle being left attached to each. The tendon, thus securely held, is next divided vertically on the outer side of the knot—that is to say, about midway between the latter and scleral insertion of the tendon. The threaded needles are then passed between the distal and the proximal portions of the divided tendon in such a way as to bridge over the gap left between the two. Lastly, the two sutures are tied together. An even simpler way of forming the artificial tendon is to use two needles on one length of silk. If advancement of the antagonist muscle has formed part of the operation, the sutures should not be adjusted until the first operation has been completed. If, on the contrary, muscular elongation is alone contemplated, then before

the threads are tied the eyeball should be strongly abducted so as to leave a distinct interval before inserting the silk threads of the artificial tendon."

Landolt[1] has recently proposed a method of muscle elongation. He designed it for those inveterate cases of convergent squint in which there is marked contraction of the internal rectus, accompanied by changes in its structure and the loss of elasticity. The tendon is laid bare by a horizontal incision over the center, and stretched flat upon a strabismus hook. While an assistant rotates the globe outward the rectangle represented by the tendon is bisected diagonally. The apex of one of the right-angle triangles thus formed is united by suturing to that of the other. Another way mentioned is to divide the tendon by a series of cuts in the form of steps, and joining the last step on one side to the corresponding one on the other. By a curious coincidence, Landolt has hit upon precisely the same idea as did Stephenson. In this connection the following question suggests itself, viz., may not the result of such operations, in cases where the eyes are capable of binocular single vision, be a serious disturbance of the muscle balance, owing to the peculiar manner in which the ends of tendon are united?

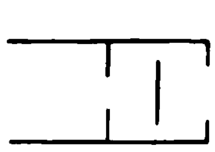


FIG. 83.

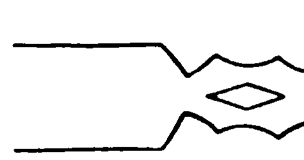


FIG. 84

Verhoeff[2] has suggested a form of tendon lengthening which is presumed to find its application only in the lowest degrees of strabismus. It consists in laying bare the tendon of the muscle toward which the globe is deflected, buttonholing it in the vertical sense and, in addition, making a series of nicks in its edges. It is through scratching out of the tendon consequent upon the opening of these cuts that the effect is obtained. Figs. 83 and 84 show the cuts closed and open. This is nothing else than a form of partial tenotomy, and Haab[3] significantly observes, in referring to the measure, "Ob diese Operation bleibendere Resultate erzielt als die partiellen Tenotomien, welche früher schon von verschiedenen Autoren vorgeschlagen und ausgeführt wurden, muss die Erfahrung lehren."

While, as before stated, some degree of vertical deviation is common in connection with horizontal squint, operations upon

[1] Archiv. d'Ophtal., January, 1905.
[2] Mbl. F. A., Band xli, 1903.
[3] "Augen-operationslehre," p. 278, 1894.

the muscles that rotate the eye upward or downward are seldom indicated. Correction of the lateral deviation usually corrects the vertical also. At all events, and generally speaking, no attention need be given to any *hypo-* or *hypertropia* until there is full redressal of the *eso-* or *exotropia*. Then, if a vertical squint persists, it is time for its surgical treatment. Its cause may be looked for either in one of the vertical recti or in one of the obliques. The vertical recti in such cases lend themselves readily to the same operative measures as do the other two straight muscles. The obliques do not. Indeed these are hardly amenable to surgical interference of any kind. The inferior may be tenotomized, and the writer has twice performed the operation, and with gratifying results; but the undertaking is both laborious and risky.

From time to time more or less complete tenotomies of the superior and the inferior rectus muscles have been advised for the cure—or as aids to the cure—of horizontal squint. Stevens, of New York, for a time, seemed truly ardent in his advocacy of such measures. Ever since the early investigations of Landolt, in regard to the ocular movements, it has been known that the vertically acting recti were, in addition, by their dual contraction, decided adductors of the globe—thus being the normal antagonists of the combined obliques. Landolt also pointed out that normally directed eyes are, relative to the long axes of the recti muscles, *already in a state of convergence*. Moreover, that, under certain abnormal conditions, the vertical recti could become abductors. Given, for instance, narrow central insertions of their tendons, especially if the globe be of large size, as in certain myopes, and the lateral muscles are lacking in tone, and we have what the writer once described as *pivotal attachment*, where there was convergent squ'nt in near vision and divergent for distance. Here the muscles and their insertions bore the same relations to the globe that two shafts with their pivots, or cranks, would bear to a wheel. The moment the rotation, in either direction, carried the pivot-like attachment beyond the center of motion the deviation became markedly manifest.

Quite recently, Jackson,[1] of Denver, in a paper entitled "Lateral Displacement of Tendon Insertions for the Cure of Strabismus," recommends tenotomy of the inner half, to three-fourths, of the

[1]Journal of the Am. Med. Assn., Aug. 19, 1905.

tendons of the superior and inferior recti, or even complete tenotomies of them, and their reattachment to the sclera in a more favorable manner, by suturing. He has practised lateral displacement by partial tenotomy on the superior and inferior recti muscle chiefly for the correction of excess of convergence, and describes his method of operating. He claims this operation is followed by no diplopia and by no more reaction than ordinary complete tenotomy. Jackson considers lateral displacement of the tendon insertions of the superior and inferior recti, in connection with tenotomy of the internus, as an effective and reliable operation for high degrees of convergent squint. He begins with a complete tenotomy of the internus, and through the same conjunctival opening the scissors are introduced and the nasal one-half to three-fourths of the tendon of the superior or inferior rectus is divided at its insertion. He strips the edge of the tendon back one-half inch or more from the insertion by means of a strabismus hook. He cites a case where this operation was performed successfully for a high degree of squint, and explains that no protrusion of the eyeball or other bad result has been observed.

Now, while there are, now and then, instances wherein, after careful study of the muscular anomalies that are present, one is convinced that there is undue tension upon one edge of a broad tendon, and that unquestionably, a well-directed partial tenotomy is indicated. But to make anything like regular practice of this kind of strabotomy is to enter upon delicate ground and to invite indiscriminate intervention in the matter on the part of muscle-snippers.. As said before, it is my belief that it is only exceptionally that one need consider the vertical muscles as factors in a squint, at least to the extent of attacking them surgically. And often even when they seem to be directly responsible for the defect, they are only indirectly so, i.e., merely because of a lack of balance or a want of dynamic adjustment on the part of the other two recti. In the pivotal attachment, just alluded to, had the internus and the externus been properly *in rein*, so to speak—rightly toned—there would probably have been no squint in either direction.

Advancement for Secondary Squint.—A goodly percentage of the squints with which one has to deal are of this variety, and, while the surgical measures appropriate to some of them might

come under the head of a form of advancement, others constitute a class by themselves, and the surgeon must resort to special methods to meet the demands of the individual case. This class is characterized not only by exaggeration of the exophthalmos, retraction of the caruncle, etc., but by that of extent of adhesions and scar tissue as well. If one fears that it will be difficult to obtain a firm forward anchorage for his suture he would better weaken the opposing tendon by a large transverse buttonhole. Then comes the task of procuring the needed raw surface near the cornea with which the tissue to be advanced is to unite. In the worst cases this can be obtained only by a laborious dissection. This can best be accomplished by the use of very small mouse-toothed forceps and scissors, beginning well back where the tissue is looser, and trying to open up a wide path toward the cornea in the horizontal meridian. If one encounters an island of scar so firmly incorporated with the sclera that it cannot be separated, it may be freshened with a small, very sharp, finely serrated curet. Now the muscle, or the remains of it, must be searched for. If nothing having the semblance of a tendon and aponeurosis can be found—if all is united in one mass with the conjunctiva—a sort of pyramidal flap, with its apex toward the cornea is formed by diverging incisions of the united membranes, putting the regulation advancement suture or sutures in near the apex, bringing the whole flap forward and securing it just as one would a tendon. In this way the deformities, at least, (and usually at most) can be corrected. Yet it is remarkable how much control is sometimes obtained by the reinstated muscle over the movement of the globe.

Accidents and other sequels consequent upon advancement are, in many respects, identical with those attending tenotomy already given. Care must be exercised to prevent operating on the wrong eye, cutting or breaking the thread, etc. The thread should be braided, not twisted, and ought to be previously examined as to strength and evenness, as well as to see that there are no little breaks in its strands. The use of so-called self-threading needles is prejudicial since they are apt to cut and make weak places. The cutting out of the sutures can best be avoided by using thread of only medium fineness and by giving it the proper hold in the tissues. Manifestly one cannot depend upon the numbering printed or

written upon the spools or skeins of thread by the manufacturers; what is No. 1 in one make is No. 2 or No. 3 in another, and so on. Thread that has been treated with a preparation of wax or paraffin is vastly preferable for several reasons. It does not snarl, it does not make a track for bacteria, and, being nonabsorbent, is easier drawn through the tissues. It holds better because bacteria do not proliferate around it and soften the parts. If, at the first dressing, it is discovered that the thread has escaped from some part of its fastenings, the fault may, in some instances, be remedied by the judicious placing of a single new thread in such a way as to counteract it. If merely too much dropping back of the tendon has occurred, without cutting out of the suture, I have been able, at times, in the one suture method, to pull the thread up tight again, twist it into a pedicle, and ligate it. Of course, if the thread is left in a bow knot at the time of the operation, the matter is simple enough.

Advancing capsule and conjunctiva with the tendon. If this be done in too comprehensive a manner, it leads to restriction of motility by tightening the check ligament in the one instance, and to advancement of the caruncle and obliteration of the semilunar told in the other.

Wounding and bruising of the parts should not only occur in the minimum degree, but should be kept as well forward as practicable so as not to interfere with what Landolt calls the normal unrolling of the operated muscle upon the globe; in other words, the true advancement effect is nullified in proportion as the adhesions reach backward.

Enophthalmos after advancement operations has been referred to as an objectionable feature. It is usually insignificant, yet it affords an additional argument for operating upon both eyes in the higher degrees of squint in order to prevent an apparent difference in the width of the palpebral fissures.

GENERAL CONSIDERATIONS ON ADVANCEMENT.

Age of Subject.—A squint operation would not, as a rule, be justifiable prior to the age when it could be ascertained whether or not other than surgical measures could avail. There are exceptions, however, to this rule, as, for example, cases of congenital

strabismus with unnatural shortness of the muscle or muscles. If this were suspected, it could be differentiated from spasmodic squint by placing the patient under ethyl chlorid, nitrous oxid, or similar anesthetic, and testing the rotation of the eye with forceps. Then, too, there is that class where, without any brevity of muscle in the direction of the deviation, motility in the opposite direction is so very limited, and the degree of deflection is so high, that it is a foregone conclusion, particularly if the patient belongs to the lower and irresponsible station of life, that it is merely a question as to whether one operates at once or leaves a permanent squint.

Choice of Method.—Where there are so many effective modes this would seem to be largely a matter of individual preference. If one has happened upon or selected a method with which he has become familiar, and been uniformly pleased, he is not apt to exchange it for another. There are a few squint operations for which their authors do not claim universal application, yet any measure that is capable of causing 25 to 30 degrees of redressment of a squint is sufficient for all cases, provided both eyes are operated upon. There are relatively few instances wherein the deviation exceeds 50 degrees, and if it is better, as is pretty well agreed, since the affection in question is a binocular one, that the corresponding muscle of both eyes be operated, then the need of bilateral interference is all the more urgent. In practice, however, we cannot always count upon an opportunity of making a second operation, but may often wish to make a single sitting suffice. If one has scruples against tenotomy as a means of curing squint, he would, then, prefer an operation that, all things else being equal, would give the maximum of effect. But *are* all things else equal? The maximum of effect could doubtless be obtained by most any of the shortening processes, either folding or resection, but would the result be in every way as good as after a true advancement? The advocates of the latter would say, "No!" They believe that to give the muscle the greatest power or leverage over the globe, it should be given an attachment forward of its original one, and it is in this that a veritable advancement mainly consists; that, while there are most excellent measures among the shortening operations, their sphere is limited to the lower degrees of squint. Admitting that they who prefer advancement are right, what kind of an advancement can

be reckoned upon to give the greatest and best effect? For it must be remembered that permanent over effects, or secondary squints, do not occur after advancement operations except where too much tenotomy has accompanied the operation. Two little effect, even after both eyes have been operated, is frequent. Moreover, to get very decided *permanent* effect one must strive for yet more decided primary effect, i.e., *over-effect;* for some dropping back of the tendon is inevitable. As to the degree of primary effect, one must be guided by his judgment —knowing, as he ought, the angle of the squint and other peculiarities of the case in hand. In divergent and paralytic squint, it goes without saying that the over-effect must be specially pronounced. *The forms of advancement that will give the maximum turning of the globe with the minimum resection or obliteration of tendon are those whose sutures begin to take their proximal anchorage beyond the nearer vertical tangent of the cornea* (Fig. 85).

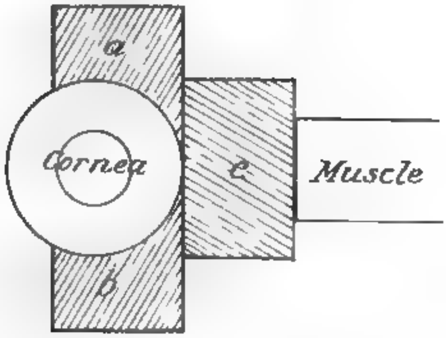


FIG. 85.—Anchorage obtained in the spaces *a* and *b*, i.e., on the corneal side of the nearer vertical tangent of the limbus, affords a more positive advancement than one obtained in the space *c*.

The anchorage *must* be *beyond* the tangent; it will not do to be merely *even* with it. This is not to imply that those methods wherein said anchorage is between the cornea and the operated muscle are necessarily inferior. Doubtless there are good measures and bad ones in both classes. Given an equally good one on either side, it becomes simply a question as to whether or not one wishes to increase the turning of the globe at the expense of the tendon. Given two equally good measures in either class, it becomes largely a question as to which is simpler. From reading the descriptions one would conclude that there are needlessly complicated procedures in all the classes, but descriptions are apt to be misleading in this respect.

Most all the single suture advancement operations have the merit of drawing the muscle straight forward. This is not true,

however, of those wherein the thread is knotted in or tied to the tendon. It can be done with the multiple suture methods that have a meridional thread, by tying this first, but this, again, is in the way of a full effect. A certain vertical deflection of the muscle is difficult to avoid in the two suture modes. Another advantage of the single suture is that it facilitates removal. It is a curious fact that there is more dread and flinching on the part of the average patient relative to the taking out of the thread than to the making of the operation itself. One has merely to grasp the knot with the forceps and cut the suture. If the knot is not held by the forceps one risks attempting to pull it through the stitch canal.

A great deal has been said about the advantage of this or that advancement procedure in that the arrangement of the suture or sutures in the tendon tends to prevent its cutting out. From an abundant experience with his own method, both as performer and onlooker, the writer has long since come to the conclusion that it is far easier for the average surgeon to obtain a firm hold for the thread in capsule and tendon than in the globe; and this with regard to an operation where the suture is *not* tied fast to the tendon by "surgeon's knots." It may be that more is lost than gained by these ligations of the tendon.

The object of the accompanying tenotomy being only for its temporary effect, the writer often omits it in the lower degrees of squint, but, owing to the fact that the greater the rotation the greater the resistance of an unweakened opponent, tenotomy has come to be an auxiliary in all whose angle is above 25 degrees. If advancement of the corresponding muscle of each eye fails to correct the squint, rather than make a tenotomy to complete the cure, a second advancement is made in case of the first eye operated. I consider advancement preferable to tenotomy for every form of squint, latent or manifest, where surgical measures are at all indicated.

Orthoptic and fusion training are instituted at the earliest moment after operating in order to enhance the result. Binocular single vision, however, is not the rule in these cases. But, as Landolt has pointedly said, the best that the most skilled can do is to put the eyes approximately right and rely upon Nature to do the rest. So, by these exercises we strive still further to assist Nature.

The length of time one should wait before making a similar

operation on the fellow eye must be regulated by circumstances. In children, and all those where there is hope of gaining the end by the help of other means, from six months to a year is not too long. As regards older subjects, and those with high and incorrigible amblyopia, it is useless to wait longer than a month or so.

Anesthesia.—Wherever feasible one should make the operation under local anesthesia, and it is the writer's custom even in case of small children—from 7 to 12 years of age—although they are prepared for narcosis, to begin under cocain. If they bear it uncomplainingly, well and good; if not, they are narcotized. A pretty large percentage of these little ones can be operated without being put to sleep. The suggestion of Eales,[1] of making the tenotomy and first step of the advancement under cocain, and then giving ethyl chlorid or some such anesthetic for the sewing seems a plausible one. The subconjunctival injection of cocain is not free from danger, and makes a mess of the tissues concerned. Three or four drops of a 4% solution made from a good quality of cocain produces perfect anesthesia in most eyes, though it is well to put a drop or two into the wound as soon as the conjunctiva is incised, both for the tenotomy and for the advancement.

As to *safety*, advancement ranks about as high as any operation that is made on the eye. In all my experience I have never seen but a single eye that gave me serious alarm thereafter. This was a dispensary patient who was allowed to go home directly from the operating-room, but with instructions to report on the second day. He did not return till the end of the fourth day. The bandage was filthy, the dressing was off the eye, and there was septic tenonitis at the site of the advancement, with a deep infiltration in the nearest segment of the cornea. The suture was at once removed, the man put under treatment in the hospital, and the eye made a complete recovery.

A neat and effective advancement, though safe and simple as to detail, is by no means easy of execution, the great difficulty lying in the deep anchorage required for the sutures in the globe. The older the subject, the more difficult this becomes. To pierce the superficial layers of the sclera for the requisite distance without going through and in such a way that the tunnel of the needle will

[1] Brit. Med. Jour., Jan., 1888, p. 349.

not be ripped open in drawing the suture through is the key to the situation. Fine needles, of proper shape and irreproachable sharpness, together with steadying the globe by holding with fixation forceps the tendon at its attachment, go a long way toward lessening the labor of this step; though nothing but practice will give the necessary skill. This can be attained to a tolerable degree by operating upon pig's eyes in a mask.

To give the lines of anchorage a highly divergent direction serves three important purposes: 1. It prevents the thread in its backward course to the loop from overlying the cornea. 2. The advancement can be more positive, i.e., it allows the tendon to be drawn quite up to the cornea. 3. Any dropping back or cutting of the thread is minimized in proportion to the degree of divergence, hence magnified in proportion as the lines of anchorage approach parallelism. On the other hand, the solidity and security of the anchorage is increased in proportion as its lines become more nearly horizontal, for the reason that the strain of the thread is thus distributed along the sides of the stitch canal, whereas, the more divergent the lines, the more the strain is concentrated at the distal extremity of the canal. These points are illustrated by Fig. 86; *aa* indicate the further ends of the scleral anchorage, situated at five mm. from the cornea on the vertical meridian. This insures a maximum advancement without contact of the thread with the cornea. Now, in order to give greater firmness to the hold of the thread in the sclera it is not inserted along the lines *ea*, but is made to follow the lines *ca*. Still greater lateral strain in the anchorage would be obtained by following the lines *c′a*, or to make them actually parallel, but this would add greatly to the difficulties of the operation. It would also shorten the anchorage.

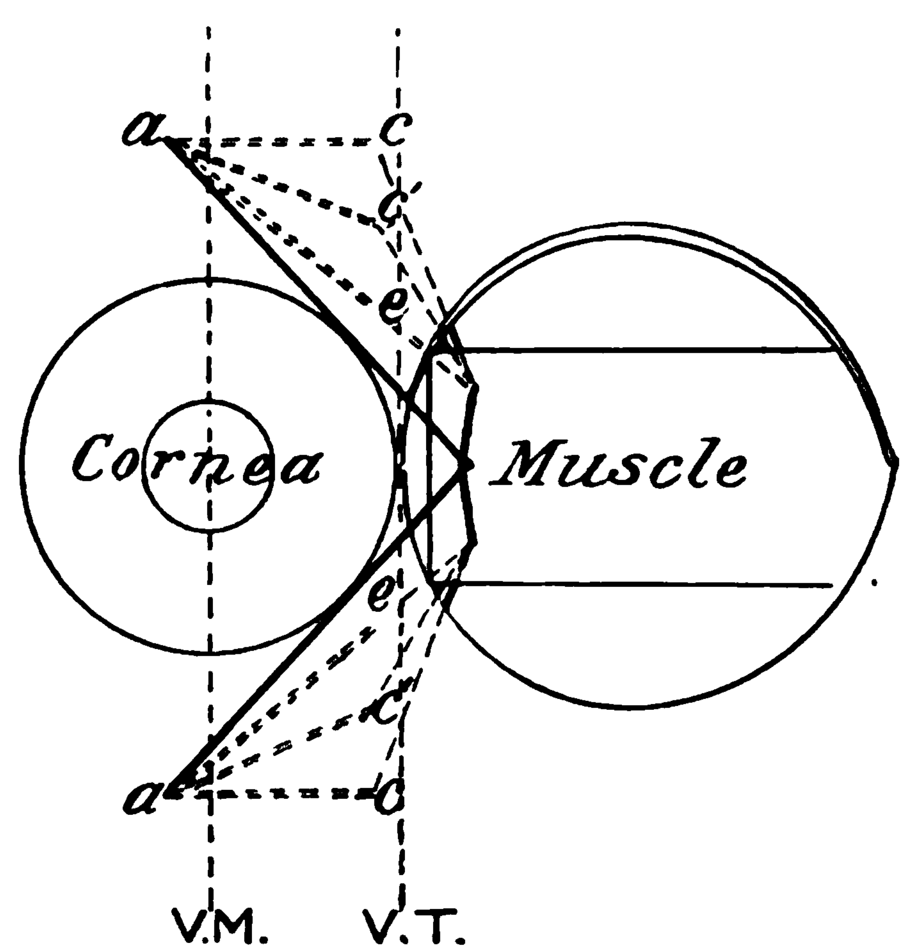


FIG. 86.—The anchorage cannot be long. Essential that distal portion should be deep.

CHAPTER V.

OPERATIONS UPON THE LIDS.

EVERSION.

Eversion of the lid consists in turning it so as to expose its conjunctival surface, together with the retrotarsal folds, and to accomplish which the essential feature implies the inverting of the stiffening plate of the lid, viz., the tarsus. The ends sought in everting the lids are manifold, such as examination and topical treatment of the conjunctiva, the removal from it of foreign bodies, the excision of tumors of the tarsal plates and the making of various other operations. Although the performance seems a simple affair, it is really one involving considerable sleight, and the constant need of the procedure gives it importance. Moreover, the fact that the eye, naturally a sensitive organ, is rendered all the more so by the affections requiring eversion, makes it incumbent on the operator to be deft in its execution. The novice is hardly expected to do the thing without awkwardness, but that so many of the older and more experienced eye surgeons should perpetually exhibit this quality in the little act is truly surprising.

Method for the Upper Lid. (Fig. 87).—Standing or sitting in front of the subject, the operator rests the tips of the fingers of his right hand upon the brow; with the thumb and index of the left hand he takes hold of the lashes, tells the patient to look all the while far downward and to refrain from squeezing. He pulls the lid well down on the stretch and slightly away from the eyeball, places the right thumb on the skin opposite the upper border of the tarsus, pressing it downward and backward rather slowly and steadily at first, till, feeling that he has the plate well in hand, he gives a quicker down and back impulse to the upper border and an equally quick forward and upward one to the free border, ending the move in turning the tarsus completely upside down (Fig. 88). The right hand is removed as is the left forefinger, but the left thumb remains to hold the lid everted, by pressing the lashes back against the

globe and having for solid support the rim of the orbit above (Fig. 89). If, as is sometimes the case, the lashes are wanting, a

FIG. 87

stiff probe or similar instrument is used to press the convex border of the tarsus down and back, till the free border pouts very decidedly, when with the left thumb it is adroitly shoved up, rolled

back, and held, possibly with the probe left *in situ* to help (Fig. 90). This instrumental eversion is useful also where the patient is touchy or the orbicularis is spasmodic, but it is best, as a rule, to rely upon the fingers alone. In fact, to be able to make a neat eversion with the left hand unaided by the right is a most convenient acquire-

FIG. 88

ment, for the reason that it is so often desirable to have an instrument in the right, all ready for use. To do it, the office performed by the left thumb and index is precisely as described for the two hands and in lieu of the right thumb, the upper border of the tarsus is manipulated by the left middle finger.

Epilation of the margins of the lids is advisable as regards any hairs that are in the way of proper application of remedies, as in blepharitis or for the temporary riddance of any that offend by

FIG. 89

touching the cornea, or conjunctiva, and is done by means of the cilia forceps (Plate V).

The chief requirements of this instrument concern the jaws, which, to be right, are rather broad two to three millimeters—slightly rounded at the corners and of faultless coaptation. The

depth of the articulating surface is about one and one half millimeters and the width, of course, the same as that of the jaw itself. The shanks are sufficiently rigid to withstand the necessary pressure

FIG. 90

without bending toward each other, as this would cause the tips of the jaws to open, save at their posterior angles, and to let go the hair.

Lindsay Johnson[1] recommends putting a minute quantity of cobler's wax, or resin, between the opposing jaws of the forceps, and gently heating for a second. The material will spread evenly over the blades and insure a firm grip on the hair. It can be melted and wiped off for cleansing or renewing.

The Method.—Epilation, like eversion, while it can be done, after a fashion, by the merest novice, has, nevertheless, its refinements and is cleverly done only by those who have special training. The forceps is held between the tips of the right thumb and index, jaws up for the upper lid and down for the lower. The bulbs of the left fingers are rested on the patient's brow, he is made to look down for epilation of the upper lid, and *vice versa.* The left thumb manipulates the upper lid, the left index the lower, slightly everting by pressure, raising, depressing, etc. The jaws are placed vertically astride the hair to be pulled and in contact with the skin at its base, closed—not too tightly—and gentle, steady traction made exactly in the line of the shaft of the cilium, to pluck it out by the root. Quick jerks and sidewise pulls will not do, but result in breaking off, not eradicating. The hairs, especially the tiny ones, seem to require a little time in which to relinquish their deeper attachments. The smaller the hair, apparently, the stumpier the free end, hence those that are practically invisible to the naked eye are almost as potent for harm when they touch the cornea as are the larger ones. Focal illumination made by an assistant or by the adjustable lens, attached to a head-band are valuable adjuncts. For locating the finer cilia the lid must be so managed that the pupil, iris, or nearly closed palpebral fissure will afford a dark background for the illumined hair. Strong convex spectacles, or the binocular loop, worn by the operator will greatly assist him. With all these appliances certain extremely fine hairs will remain invisible and must be nipped for cautiously along the whole length of the lid. When the resistance of one is felt or a pimple is seen to rise around it the usual time is given for it to let loose.

A wad of absorbent cotton that has been moistened with boric acid or sublimate solution and well wrung is held on the brow beneath the fingers of the left hand on which to wipe the forceps.

[1] Ophthalmoscope, Nov., 1904.

As the eye fills with tears, the lids are sponged dry from time to time, for the forceps will not hold the cilia securely when they are wet.

Electrolysis of the hair-follicles, something after the method of Michel,[1] as an auxiliary to epilation, is the only sure means of permanently eradicating the cilia, and is particularly applicable to cases of trichiasis where relatively few hairs grow inward, or, as it is termed, *distichiasis*.

The requisite implements are an electric outfit, capable of furnishing a continuous current of from one to five milliamperes. The negative electrode is fitted with a fine, sharp needle (gold or platinum), the positive, with a sponge which is moistened with salt solution. Provided there is a rheostat or controlling switch, one may dispense with a galvanometer; indeed, the best means of regulating the energy is to immerse the two electrodes in a vessel of water and gradually turn on the current until the needle throws off a stream of tiny bubbles, indicative of the decomposition of the liquid. It is then ready for use. A valuable suggestion is that of Jourdan, of Frankfort a/M., to apply shellac to the needle, then to uncover the point by scraping. This greatly lessens the pain, since it protects the sensitive skin. It also prevents punctiform scars that might otherwise ensue.

In order to introduce the needle with precision the operator wears strong, convex lenses or uses the binocular, stereoscopic loop. The patient may sit or lie. A lid spatula is inserted beneath the lid to steady it and to afford a purchase for holding and manipulating with the thumb. Or, better still, the Beard lid-forceps is clamped on (Fig. 91). The needle is pushed down alongside the shaft of the hair, till the point is well within the follicle (three to four millimeters) and the sponge electrode is applied to the adjacent temple or forehead. As soon as a boiling up of gas occurs around the needle, the sponge is lifted, or the connection button is released, the needle withdrawn and the hair lifted out. *Lifted* is the word, for if any traction is needed, it is a sign that the electrolysis has been incomplete and, to be effective, must be repeated. The performance is anything but agreeable to the victim, but the pain is much greater if the needle is taken out without stopping the current.

[1] St. Louis Clinical Record, Oct., 1875.

Chalazion. The usual manner of removal is by incision and curettage. The tumor is attacked from one of three directions:

1. **Marginal Route.** From the free border (Agnew).
2. **Conjunctival Route.** From the inner surface of the lid.
3. **Cutaneous Route.**—From the external surface of the lid.

The first is preferable for the removal of the softer or cystoid varieties particularly, when not situated in the extreme upper portion of the superior tarsus.

FIG. 91.—Electrolysis of cilia.

The only *Instruments* needed are a thin, sharp Beer's knife or a straight, keen bistoury and a small, oblong sharp curet. A drop of cocain solution is instilled.

The positions of surgeon and subject, as concerns the upper lid (Fig. 92), are the same as for slitting and syringing the lower canaliculus (p. 134). The lid is slightly lifted from the globe by catching hold of the lashes with the right hand, the left forefinger is slid beneath, with the palmer tip in contact with the tumor, the left thumb is put in contact with it on the outside and it is held as one would a pea -

FIG. 92.

in other words, as if the surroundings of the tumor did not exist—and this hold is maintained throughout the entire operation. The lid is turned slightly away from the eye and the incision is made exactly in the mid-line of the free border of the tarsus, the flat of the blade corresponding to the flat of the lid, and the point aimed at the center of the tumor. Having penetrated the chalazion, the knife is rocked slightly, to insure free opening of the wall, and, in withdrawing, the soft contents are squeezed out by pressing together the left finger and thumb. Still grasping the tumor, the tiny serrated curet is introduced, the unexpressed contents laded out and the walls of the cavity well scraped. The left finger and thumb feel the movements of the curet and are a guide to its work. As the instrument is removed, they are approached to hold the opposite sides of the opening tightly together and thus held for a few moments, else it would fill with blood and tend to disparage the result. The materials for applying a compressive bandage are ready at hand, so that as the lid is let go, the occluding pad, with its facing layer of wet cotton, is applied, and the simple bandage (p. 15) tied over it. This can be done in such a way that there will be no let up in the pressure upon the site of the chalazion, hence no possibility of a blood tumor forming. Twelve hours is long enough for the bandage to be worn, after which simply bathing the eye with hot water is sufficient. The advantages of Agnew's method are simplicity and the leaving of neither a visible scar of the skin, nor an irritating one of the conjunctiva.

Wilder, of Chicago, has invented a lid-clamp, shaped like the letter U (Plate IV, No. 79). With this he surrounds the chalazion, then injects a few drops of cocain solution through the border of the lid into the tumor. The clamp serves both to keep the cocain from entering the general circulation and to prevent hemorrhage, while the cocain renders the cutting and curetting painless. A drop of the solution previously put on the underlying conjunctiva also helps to do away with the pain of the clamp.

Removal from the *inner surface* of the tarsus, although the favorite mode with a few operators, is chiefly indicated when the inflammatory process has gone so far in that direction as to have produced either a spontaneous opening or the sprouting up of granulation masses. An incision is not necessary in most instances, merely

eversion of the lid, cocain and a drop of adrenalin, and thorough curettage. A clamp and sutures are uncalled for. Other indications than those just alluded to hardly exist for the method in question, seeing that either the marginal or the cutaneous modes offer superior results. In truth, large chalazions, extirpated from the conjunctival side, have been followed by troublesome trichiasis.

The cutaneous opening is resorted to by many as a customary procedure, and has certain advantages. For the hard, fibroid chalazions and those softer ones whose seats are high up in the superior tarsus, this is by far the best method.

The instruments needed are a lid clamp (Desmarre's, Plate VI, is probably the most suitable, but Snellen's also answers well) small, mouse-tooth forceps, small scalpel or bistoury, Steven's strabismus hooks, small, blunt scissors, needle forceps, and a fine curved needle, carrying No. 1 braided silk thread. Narcosis would be admissible only in case of a child, either in years or nerves.

A drop of cocain solution is put into the eye to make it tolerant of the clamp. The plate of the latter is slid beneath the lid, the ring made to encircle the chalazion and the screw tightened. This appliance insures hemostasis and steadies the field of operation. The hard, rubber lid spatula may be substituted for the clamp, but it must be held by an assistant. A transverse incision is made (that is, parallel with the free border) over the tumor and extending a short distance beyond it at each end through integument and orbicularis, down to the tarsus, and held open by the little strabismus hooks. The fibres of the muscle are pushed aside, the tumor seized with the forceps, or a minimum-size, short tenaculum does equally well, and dissected with knife and scissors much as one would shell out a sebaceous cyst. If practicable, the conjunctiva beneath the chalazion is left intact, but no part of the abnormal growth is left behind in order to avoid making a hole clear through, as to do so would do no special harm. The opening is cleansed, but not until after the removal of the clamp and the stanching of the blood is the suture introduced. One suffices, and it is taken out after twenty-four to thirty-six hours. The dressing may be the regulation bandage, a patch, or adhesive strips.

Canthoplasty.—Technically, this word signifies an operation for the correction of an anomalous condition of the commissure—

usually the outer—of the lids and is to be distinguished from canthotomy or tarsodialysis, which means merely a cutting of the canthus. According to its common acceptation, however, the term is used in both senses, yet with this difference; simple incision of the canthus, without the addition of sutures, is called *provisional canthoplasty;* and the more finished operation, wherein there is external tenotomy oculi and the divided conjunctiva and skin are stitched together or yet further elaborated, is known as *definitive canthoplasty.*

The *first* is applied, for example, to the temporary elongation of the palpebral fissure that is made preliminary to exenteration of the orbit, to the enucleation of a globe of extra size, to the extraction of cataract where the conjunctival sac is much shrunken, and to relieve pressure, as in phlegmon of the orbit, in the intense chemosis of gonorrheal ophthalmia, and in panophthalmitis.

The *second*, to permanent extension of the outer commissure for the correction of blepharophimosis, for anchyloblepharon, and for the damaging lid tension in chronic trachoma. It is also an important part of many operations for entropion and is occasionally the sole measure adopted for the cure of spastic entropion. It may be stated in passing that canthotomy, pure and simple, is seldom practised nowadays, as even in most of the instances just given it is followed by sutures. C. R. Agnew, of New York, in 1875, was the first to demonstrate the immense value of canthoplasty as a therapeutic measure in inflammations of the conjunctiva and cornea, such as the more severe phases of phlyctenular and interstitial keratitis and trachoma.

Agnew's method, a modification of that devised by Von Ammon in 1839, the one chiefly in vogue, is here described.

The *instruments* comprise large and small straight, blunt scissors (Plate IV, Nos. 53 and 54), mouse-tooth forceps, needle-holder, and two or three fine curved needles. General anesthesia only when absolutely necessary. Local anesthetics help slightly. The patient lies on the table.

First Step.—The outer commissure is held moderately open by the left thumb and index, one blade of the large scissors is slid into the outer cul-de-sac as far as it will readily go, its edge exactly beneath the angle of the lids and in line with the closed palpebral fissure. The other blade is closed down until it touches the skin, a good grip is

taken on the handles, so that the blades will not "buckle," and with one firm snip the cut is made. This should be from one to one and a half centimeters long, according to the demands of the case. Although the cut is usually made in a perfectly horizontal direction, it would seem that in many individuals the scar would conform better to the natural topography about the outer canthus if it were given a somewhat downward inclination. One should bear in mind that a part of the accessory lacrimal gland lies in this region and strive not to injure it wantonly. There will be some bleeding, but it usually ceases spontaneously.

Second Step.—Division of the external canthal ligament.—The free border of the upper lid is grasped by the left thumb and index, pushed slightly up to open the spaces between the severed skin and conjunctiva, the small scissors, closed, are put into the upper opening to feel for the ligament. The lid is now pulled forward and toward the nose, so as to make the ligament taut, when the scissors are opened slightly, the blades are pushed up astride the ligament and it also is cut with a single snip. Some authors state that the conjunctiva is unavoidably incised in dividing the ligament; such is not the case, for with delicate scissors and a little care, neither the skin nor the conjunctiva need be wounded. If the snip is successful the lid at once gives way under thumb and finger. If it fails thus to yield, another and more careful effort must be made. The same procedure is repeated on the lower section of the ligament.

Third Step.—Placing and tying the sutures.—An assistant opens wide the extended commissure. It will be observed that the cut in the skin is longer—often very much so—than that in the conjunctiva. Now, all the descriptions of the operation that I have ever read and all the many cuts that I have seen illustrative of it, teach that the angle of the conjunctival opening is joined to that of the skin. This is precisely what Agnew insisted should *not* be done. And with good reasons, to wit, because of the inequality in the length of the angles alluded to, thus to unite them, means the obliteration of the external cul-de-sac; not only this, but the conjunctiva is so stretched to meet the skin at this point, that an unseemly bridle or band results that is particularly noticeable when the globe is in adduction. Instead, therefore, following Agnew, after picking up the conjunctival angle with the needle, it is carried outward as far as it

will go without any stretching and is joined to the upper lip of the incision (Fig. 93). Another suture is placed to unite the lower skin and mucous lips, and the operation is finished—unless, perchance, one chooses to put in a third or superficial suture to close the small skin angle thus left unclosed. As each suture is put in, if it be not tied at once, the two ends of thread are laid together on the temple where an aid places a finger on them to insure keeping them to themselves. They are tied with the canthus stretched open, in order to see that they are true and do not cut out of the conjunctiva.

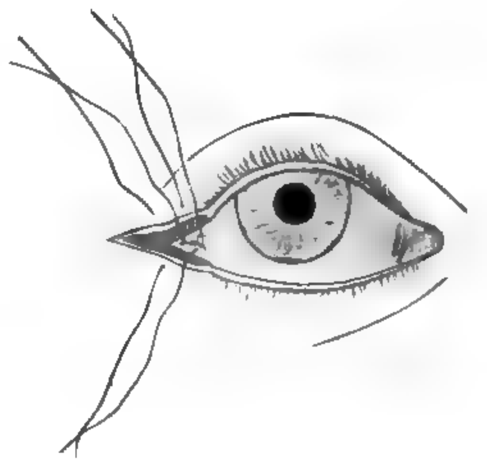


FIG. 93 —Canthoplasty.

Several other ingenious and effective varieties of canthoplasty have been devised and extensively practised. Attention is called to three:

1. Richet[1] resected a dart of skin and tarso-orbital fascia whose base was the canthus and whose point reached outward horizontally one and one-half centimeters. A median horizontal incision was made in the outer wall of the external conjunctival cul-de-sac thus laid bare, and the cut edges were stitched to those of the skin.

2. David Prince,[2] of Jacksonville, Ill., made a cutaneous incision, beginning on a level with, and three or four centimeters from the commissure, down and in, parallel with the lower lid border, one-third to one-half of the length of the latter; then from this point out and up back to the level of the canthus, but several millmeters further toward the temple. The curved angle of skin thus marked out was dissected up from apex to base. A third incision joined this base and the canthus, the upper lip of which was undermined for a centimeter or more toward the brow, a double-armed suture

[1] Trait d'anat med. chir., 1851.
[2] Am. Jour. of the Med. Sciences, 1866, p. 381.

was put through the point of the curved flap outlined by the first two incisions; it was tucked up into the pocket made by the undermining of the upper lip of the horizontal incision, the suture brought out through the skin beneath the supercilia and tied over cylinders of buckskin or other material. The remaining angular opening was closed by sutures, which completed a clever method for combining canthoplasty with correction of moderate ectropion of the lower lid.

3. Chalot (V.)[1] makes an incision through the skin only, extending from the canthus outward one and one-half centimeters. This he crosses with a vertical skin incision, made flush with the canthus, the two forming a capital H, supine, against the canthus. The two angles he dissects or undermines, exposing a bridge of conjunctiva. This is incised above and below, turned outward, and sutured to the angle of the cutaneous incision.

Tarsorrhaphy, or as it is sometimes termed, blepharorrhaphy, is an operation having for its object the occlusion of all or a portion (total tarsorrhaphy, or partial tarsorrhaphy) of the palpebral fissure. It is called external, median, or internal, respectively, as it concerns the corresponding division of the fissure. Internal tarsorrhaphy is sometimes erroneously called median, after the German fashion, as, for example, in A. Duane's translation of Fuchs' textbook (D. Appleton & Co.), p. 727, 1892. Like canthoplasty, the end sought may be a permanent one (definite tarsorrhaphy) or temporary (provisional tarsorrhaphy).

Some form of the operation is indicated in lagophthalmos (paralysis of the seventh nerve with ectropion), in neuro-paralytic keratitis (paralysis of the fifth nerve), in reducible exophthalmos, as of Basedow's disease or the proptosis after injuries, in paraphimosis, and in certain surgery undertaken for the restoration of the lids and conjunctiva, to hold them in position during the healing process.

Total tarsorrhaphy, literally speaking, either temporary or permanent, is not admissible, since in the first instance it means difficulty of reopening the outer canthus should this become desirable later, and in the second, retention of the secretions of the eye. A more or less extensive median operation is better in both instances.

External tarsorrhaphy. Occlusion of the outer portion of

[1] Trait. Elem. de Chir. et de Med., Paris, 1900, 3d edition, p. 711.

the fissure, as first practiced by Walther, was frequently resorted to previous to the invention of the median method. It was done by "scalping" the lids or excising strips of skin containing the follicles of the cilia (Fig. 94) from the outer canthus for varying distances inward, owing to the degree of closure desired and uniting the raw edges by sutures. The method is still resorted to, at times, as a permanent feature, especially in connection with operations for the correction of ectropion of the lower lid, from laxness, and with eversion of the punctum; but it should never be done if one expects later to undo the work.

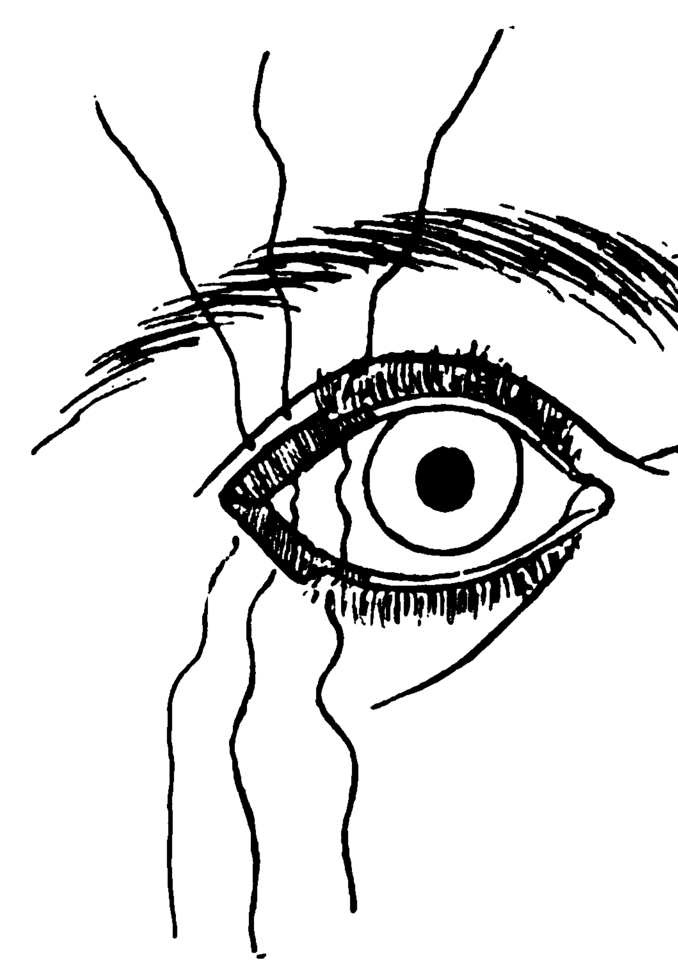


FIG. 94.—External tarsorrhaphy.

Fuchs is the author of a method of external tarsorrhaphy that could be converted into internal, and which is characterized by great solidity of the union produced between the lids (Fig. 95). Briefly, it is thus: beginning at the outer canthus and extending inward the desired distance, an intermarginal incision is made, whereby the lid is split for a depth of five or six millimeters into tarsal and cutaneous leaves. At the inner end of the slit a vertical incision is made in the skin half that extends to the bottom of the slit to allow the latter to gape. Corresponding incisions are made in the upper lid with the addition of a second perpendicular incision in the skin half at the canthus. The upper extremities of the two vertical cuts are joined by an incision, and the parallelogram thus outlined, and which contains the hair bulbs, is excised. A double-armed suture is passed from within outward at

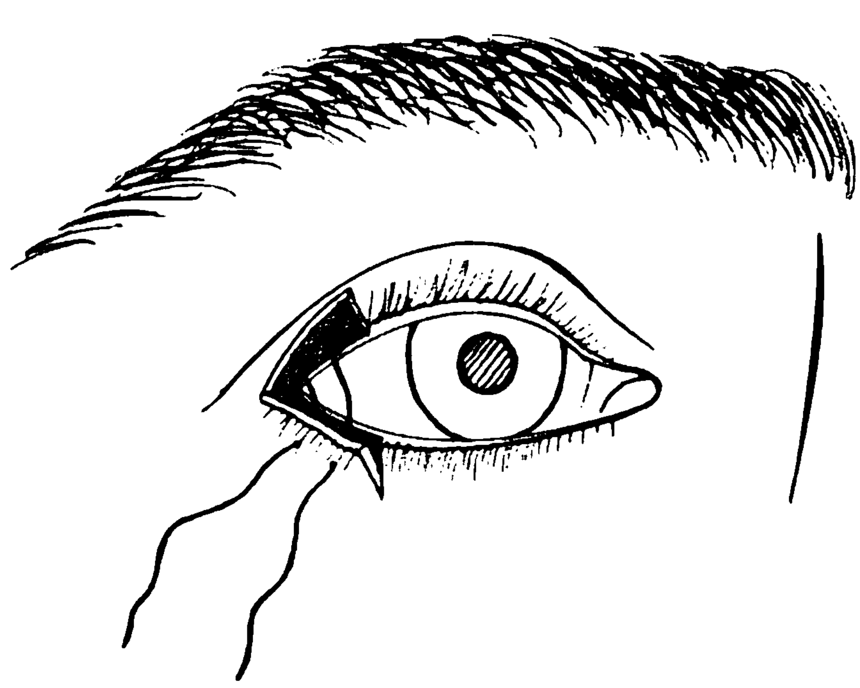


FIG. 95.

the middle of the denuded portion of the upper tarsus and, in the same manner, through the skin flap of the lower lid and tied over a cylinder of some appropriate material. In closing the lids and knotting the thread the inner surface of the loosened skin flap is made to coapt with the raw surface of the upper tarsus. To complete the operation, a few, fine, superficial sutures are put in.

Internal tarsorrhaphy was introduced by V. Arlt, for eversion of the punctum. It consisted in the resection of a horseshoe-shaped strip of skin around the *lac lacrymale* close to, and surrounding the inner canthus and uniting the upper and lower halves by sutures, thus preserving the puncta and canaliculi—a sort of artificial epicanthus (Fig. 96). The great Viennese was not extensively imitated in this respect. It finds its chief indication in those slight eversions of the puncta that are so productive of annoying epiphora, and that are so unsatisfactory as to their treatment by conservative means. All that is necessary is to close the semicircle that constitutes the canthus itself—or, what the French call "the grand angle." This is accomplished by paring with delicate curved scissors a very narrow strip, just where skin and conjunctiva meet, rather inclining to the skin side, being scrupulous to avoid wounding the canaliculi and to stop safely short of reaching the puncta. The opposite raw surfaces are united by fine interrupted sutures, which are removed at the end of two or three days.

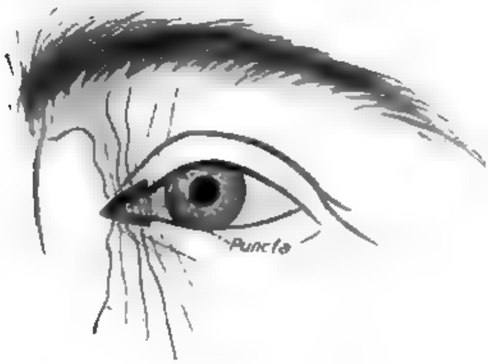


FIG. 96.—Internal tarsorrhaphy.

Median tarsorrhaphy (Fig. 97), or the forced agglutination (more or less extended) of the opposing surfaces of the lid borders at or near the center of the palpebral fissure, was first done by Bowman; but to Panas is due the credit of devising the improved mode. It is the most suitable operation, whether provisional or definitive, and is made as follows:

The lids having been carefully approximated, one selects the

location and marks the extent of the proposed occlusion. The best way is by means of tiny pricks with knife, to cause red points of blood. If the eye has useful vision, the site of the operation is so placed that in looking at distant objects the *outer* opening is utilized, and at those close up, the *inner* one. This would make the occluding bridge a trifle to the nasal side of the center, the point that is preferable from an anatomical standpoint also. A lid spatula is placed first in the lower fornix, for when the upper lid is done first the bleeding interferes with work on the lower. The lid is pressed firmly against the spatula to steady it if no clamp is used, and a thin slice of the margin is removed by means of the convex scalpel. I have found the Beard forceps described on page 99 the most convenient instrument for steadying the lid during this step. It is applied just as if for making the intermarginal incision for receiving a graft, the screw tightened, and the lid everted. The raw surface prepared need not be more than four or five millimeters long, though this must be regulated by the judgment of the operator. Its width should include only the tarsal partion of the free border, i.e., the adjacent cilia and their follicles are spared. An exactly contiguous spot is pared on the upper margin. Two sutures are passed in through the lower lid and out through the upper, the raw areas put nicely in apposition and the thread tied firmly over a short section of soft-rubber tubing or a cylinder of gauze or cotton. It is best to reinforce the sutures by strips of adhesive plaster. Over all, the usual dressing and bandage. The spring of the rubber tubing will take up the slack of the thread caused by any slight tendency to cut out; yet, to make surer, one may tie bowknots, so that they may be untied, in case of early separation of the lids, and the sutures again drawn up. The thread is removed after four or five days.

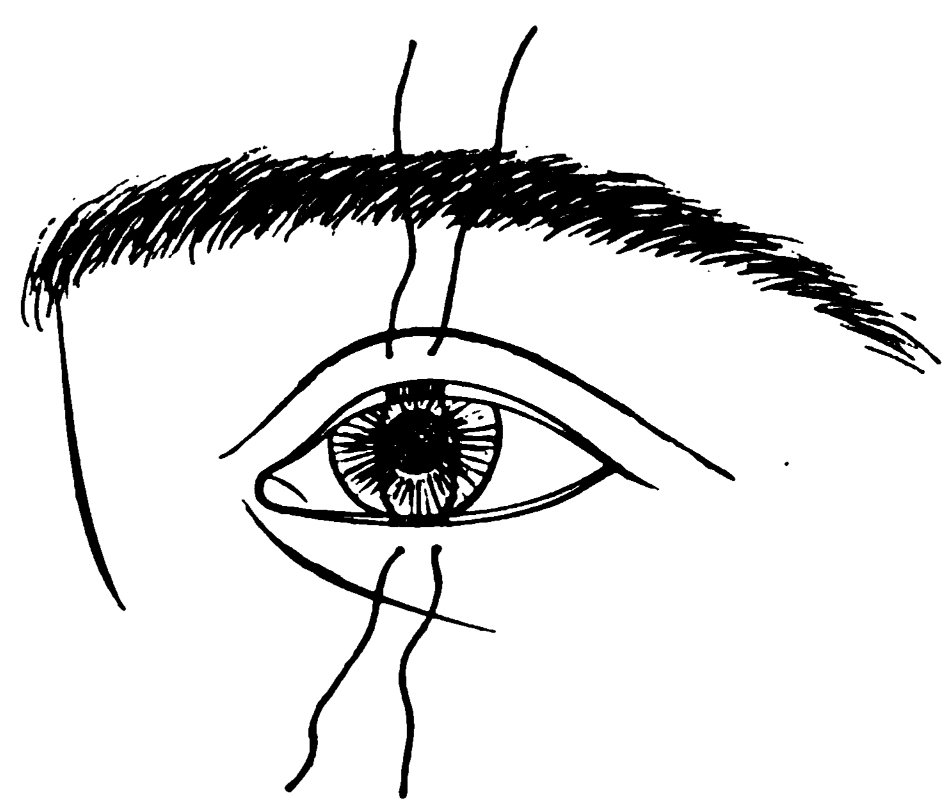


FIG. 97.

In course of time the free portions of the lid borders, although closed at first, become curved or concave, causing two elliptical openings which serve admirably for vision—the outer for distant and the inner for near, yet not sufficiently wide to give rise to trouble with the cornea (Fig. 98).

Exsection of the Tarsus.—The cutting out of all or a portion of a diseased tarsus was done as far back as the Middle Ages. It was first undertaken for the relief of cicatricial entropion. To this end, Saunders[1] in cases of shrunken and incurvated tarsi, removed them entirely. In this connection, the procedure has been superseded by modern methods, as described under Entropion. The operation is resorted to after fair trial of other means of treatment has failed to effect a cure or when the circumstances are such that the other means cannot be consistently carried out. It is indicated in the severe tarsal forms of vernal catarrh and in obstinate chronic trachoma characterized by deep infiltration and hypertrophy and degeneration of the tarsus, accompanied by persistent pannus and recurrent corneal ulcers. (For description see page 356.)

FIG. 98.

C. Magnani,[2] of Smyrna, as a precaution against ptosis, after the operation, before tying the threads to close the wound, opens it wide and puts a double armed suture into the deeper portion of Müller's muscle, then carries the needles up and back (lid inverted), and causes them to emerge from the skin near the cilia. He, then, closes the wound, turns the lid back into position, and, lastly, ties the external thread ends over a tiny glass bead. If the operation is done after the manner here described, however, there is no extra inclination to ptosis. It will be remembered that there is an inherent tendency in many of these chronically inflamed lids to both ptosis and entropion.

The usual dressing is applied, though whether to one or both

[1] Treatise on Diseases of the Eye, 1811.
[2] La Clinica Oculistica, Oct., 1903, p. 1460.

eyes is a matter which is left to the judgment of the operator. If there are knotted threads touching the cornea, both eyes should be bandaged, the better to insure immobility of the globes. The sutures are removed on the fourth day.

Operations for Epicanthus, or Rhinorraphy.—Von Ammon[1] first described this congenital deformity of the nose and disfigurement of the inner canthi under the name it bears, and invented an operation for the correction of the ocular part of the defect which he

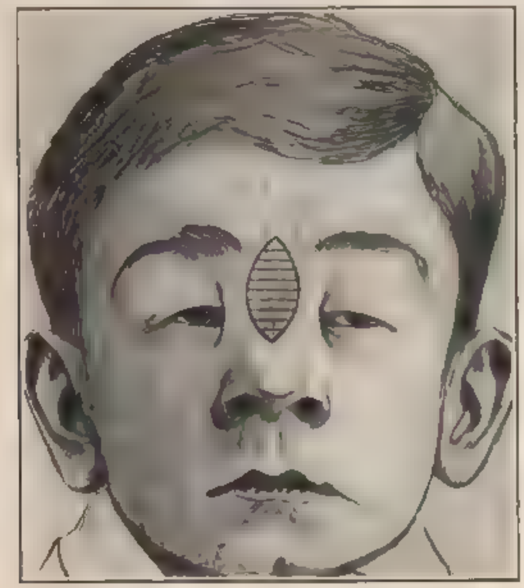


FIG. 99. Knapp's Rhinorraphy.

called rhinorraphy. This consisted in pinching up a vertical fold of skin on the bridge of the nose sufficient to rid the canthi of the redundance, marking out the base of the fold in ink, excising it, inserting silver pins, as in the operation for harelip, and closing the opening by means of thread wound on to the pins, figure-8 fashion. This is known as *median* rhinorraphy.

De Wecker[2] modified the operation by putting two or three large, curved, threaded needles through the base of the pinch-up fold, in-

[1] Darstellungen, etc., 6, 1841.
[2] Trait. Comp. d'oph., vol. 1, p. 180.

stead of outlining it. He then cut it out with scissors close to the needles, and brought together the edges of skin with the threads.

Knapp[1] still further modified the procedure by removing a diamond or rhomboid section of skin, long axis vertical, from the center of the nose, undermining the edge for some distance, laterally, closing with a number of fine interrupted sutures and reinforcing with strips of gauze and collodion (Fig. 99).

Arlt[2] excised the two semilunar pieces of integument comprising

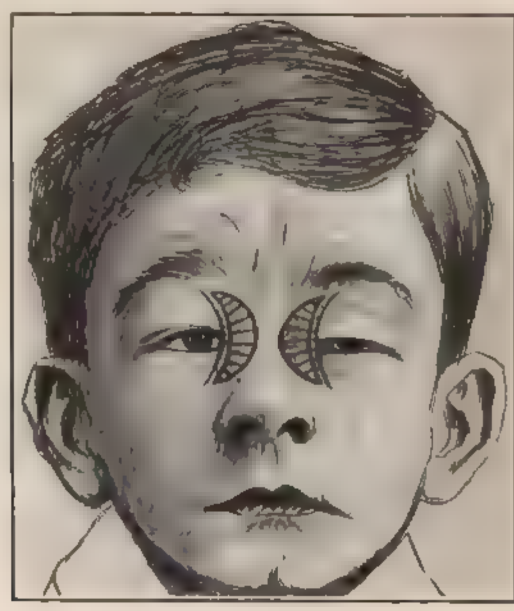


FIG. 100. Arlt's lateral rhinorraphy.

the greater portion of the epicanthal folds themselves, and in extreme cases a median ellipse from the nose also. This is known as *lateral* rhinorraphy. The sutured wounds presented something the form of an X (Fig. 100).

The use of silver pins, as in the Von Ammon operation, is apt to leave an ugly scar, as also are de Wecker's large needles and thread. Knapp's small needles and thread, with the auxiliary collodion strips, is a decided improvement in this particular. V. Arlt's

[1] Epicanthus und seine Behandlung, Arch. f. Aug. u. Ohrenh., III, S. 59.
[2] Graefe-Saemisch, III, S. 443.

method is also a good one, and for it Knapp's small sutures and collodion may be utilized. The extra scar is hidden by the spectacles which the subjects of epicanthus usually require.

I would suggest trying the omission of the rhinorraphy and, in lieu thereof, the injection of paraffin, to build up the bridge of the nose, which in these cases is flat, and careful and studied resection of the epicanthal folds, free undermining of the cut edges, fine, interrupted sutures, and the support of gauze, wet with flexible collodion. Of course, every precaution must be taken to keep this collodion from entering the palpebral fissures. None but those with skill and experience in the prosthetic employment of paraffin should attempt such use of it on account of the dangers from paraffin embolism. It must be remembered, too, that the mass of paraffin that is put into the tissues has a treacherous way of sometimes changing its form and its location. The results of epicanthus operations are seldom beautiful, whatever the method, because of the usual accompanying congenital anomalies, such as ptosis, microphthalmos, squint, etc.

CHAPTER VI.

OPERATIONS FOR PTOSIS.

The original term for falling down of the upper lid was *blepharoptosis*, which, although more expressive as to the actual import of the word, has quite properly been superseded by the abreviation *ptosis*. This affection may be either *congenital* or *acquired*. Congenital ptosis is not uncommon, and, in a large proportion of the cases, it is bilateral. It is often associated with epicanthus, microphthalmus, squint, and other connate defects. Acquired ptosis is, in most instances, paralytic; that is, it is the result of paralysis of the levator from disease or from traumatism. Distinctive forms of ptosis are *ptosis senilis*, from slow progressive atrophy of the levator; *ptosis adiposa*, and *ptosis elephantiastic*, or cutaneous ptosis, from redundance and relaxation of the lid tissues; *ptosis trachomatosa*, from the combined effects of the characteristic infiltration, the blepharospasm and the ensuing shrinkage of the conjunctival sac from trachoma; and *ptosis hysterica*, or *pseudo-ptosis*, from voluntary or spastic contraction of the orbicularis. The dropping of the lid is also distinguished as *partial* or *complete*.

Whether congenital or acquired, the vast majority of cases are fit subjects for surgical treatment. This is divided into *paliative* or *provisional*, and *curative* or *definitive*. The first consists in the application to the lid of collodionized bands or strips of adhesive plaster, the insertion of restraining sutures beneath the skin, and the wearing of specially designed preventive spectacles, or artificial spring supports, of thin metal or other material, affixed to the lid borders, to act as antagonists of the orbicularis. These temporary measures are seldom resorted to; for, when intervention of any kind is called for, an operation that will give permanent relief is demanded, *or operative treatment.*

It is rather singular to note how little attention was paid to ptosis in early times—surgically, at least. By the ancients, the affection was, in great measure, confused with entropion and trichiasis; and

about the only operation adopted with reference to it was the excision of a horizontal ellipse of skin from midway of the fallen lid, and varying in size with the degree of the ptosis. No material change was made in the status of such surgery until 1880. True, von Graefe[1] had made an attempt to improve it. He incised the skin the entire length of the lid, opened wide the cut, and resected a strip of the orbicularis, about one centimeter in width and as long as the incision. The wound was closed without excision of skin. The idea was to cause subcutaneous shortening of the lid, together with the weakening of the power of the opponent of the levator, viz., the orbicularis. Mention may also be made of the curious tentatives employed by Denouvilliers and Gosselin, whereby they hoped to make a lasting perforation in the fallen lid to serve as a window through which the patient could see. During the last twenty-five years, however, ophthalmic surgeons have been tremendously prolific in the operative measure they have contrived for the correction of this defect. So numerous are they that to attempt a description of each is out of the question. We must, therefore, content ourselves with detailing only a few of them. Most of the measures in question have for object either

1. The linking of the lid directly to the frontalis muscle.

2. The advancement of the natural elevators of the lid, or

3. The inosculation of the skeleton of the lid with the superior rectus muscle.

Moreover, each contemplates, or affects, a certain amount of shortening of the entire lid.

The conspicuous manner in which the frontalis offers itself as nature's substitute for the crippled levator in ptosis early led surgeons to think of means for giving this muscle greater purchase over the fallen lid. Hunt (1838) and later Morand, thought to achieve this through more or less ingenious sliding or transposing, of skin flaps about lid and brow. Others went deeper, with the idea of making an actual anastomosis between the frontalis and the orbicularis. Vautrin, for example, brought down a fragment of the frontal muscle and attached it to the lid, while Darier tried engrafting a strip of the orbicularis upon the frontalis.

The notion of putting the upper lid in closer touch with the frontal

[1] Archiv. f. Oph., Bd. ix, 2, S. 57.

muscle by means of deep cicatricial bands was first conceived by Dransart.[1] The union was accomplished by means of sutures connecting the lid and the superciliary region, and the method has been called *deep palpebro-frontal ligature.*

Dransart employed buried, absorbable sutures (Fig. 101). He made an incision along the upper border of the tarsus, opened wide the wound, particularly above, where he carried the loosening up as far as the supercilia. A needle, armed with catgut, was made to transverse the tarsus, beginning about its middle, passing upward deep into its substance, then through the fibres of the orbicularis to

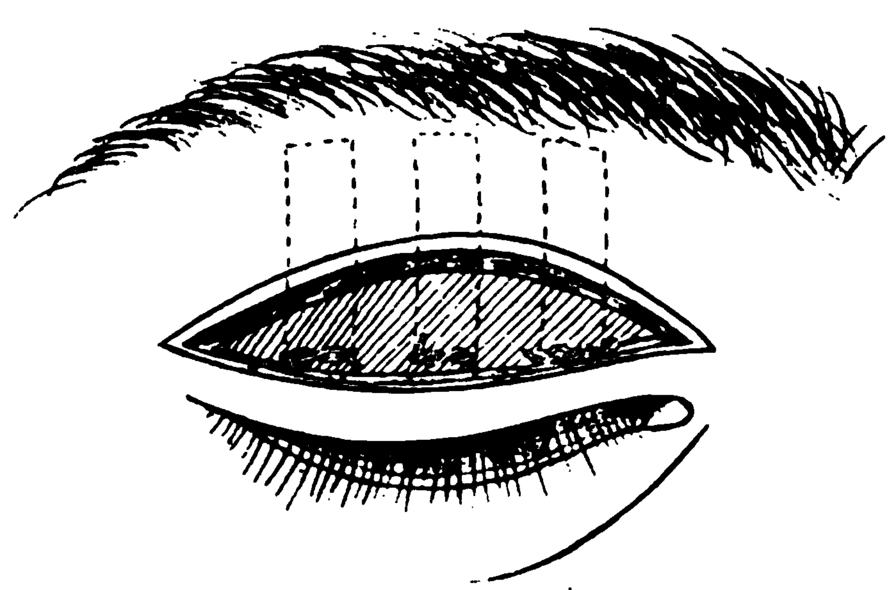


FIG. 101.—Dransart.

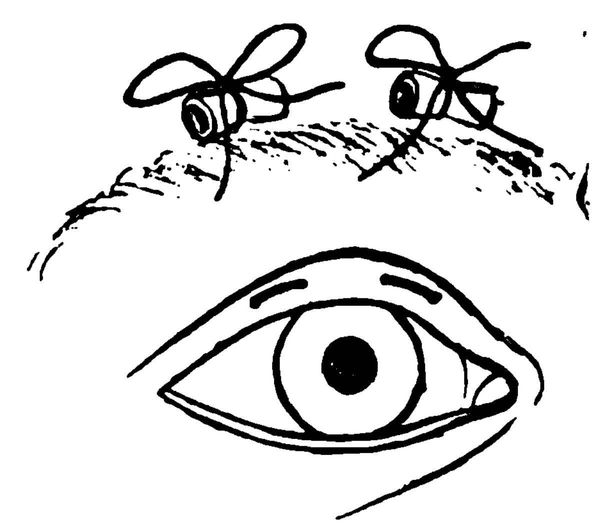


FIG. 102.—Pagenstecher.

a point just below the supercilia. Here it is turned and passed back through the same structures, alongside its first course, and was brought out on a level with its entrance. Two other sutures were introduced in the same way, parallel with the first, and all three tied. The degree of tightening could be governed by that of the ptosis, but the chief merit of the method was assumed to lie in the three cicatricial bands or cords running from tarsus to frontalis. The skin incision was closed and the buried sutures were left to their fate.

H. Pagenstecher[2] modified Dransart's procedure (Fig. 102). The operation consisted, merely, in the introduction of two subcutaneous, double-armed sutures, running from near the free border to a point above the supercilia, where they were tied in bowknots over sections of rubber tubing. These were left in place to suppurate, and were gradually tightened or drawn up from time to time, and made to cut

[1] Annals d'oculist, vol. lxxxiv, p. 88, 1880.
[2] Internat. Congress of Ophthalmology, London, 1881.

their way out. No incision was made, the originator relying for his result upon the effect obtained by the cicatricial tracts uniting lid and frontalis caused by the sutures cutting through the tissues.

De Wecker[1] went still further, and modified this operation by removing a long oval of the skin and underlying muscle, whose lower edge was four or five millimeters from the free border. (Fig. 103.) For the rest, he proceeded as did Pagenstecher.

Hess[2] modified the Pagenstecher-De Wecker procedures thus: Incision the whole length of the previously shaved supercilia, through skin and subcutaneous connective tissue (Fig. 104). Dissection downward, between integument and orbicularis, to near the

FIG. 103.—DeWecker.

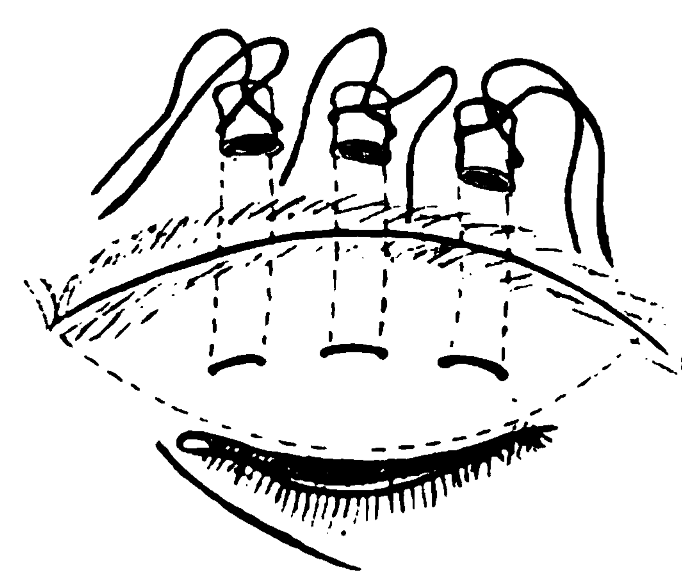


FIG. 104.—Hess.

ciliary border. Insertion of three double-armed sutures about midway of the loosened flap, which are carried up beneath the skin, brought out at a point on the brow two centimeters above the primary incision, and knotted over sections of drain tube. The upper half of the flap is by this means thrown into a horizontal fold, the size or height of which corresponds to the degree of effect, the loops of thread causing a depression that simulates the normal sulcus. The sutures are removed at the end of the tenth day.

It would seem that this measure is likely to produce rather undue shortening of the lid.

A phase of the Dransart method is that of Mules[3] (Fig. 105). Instead of silk or catgut sutures he employs gold or silver wire, which is put in after the following manner: Incision along the free border of the lid, as if for intermarginal graft, though not so deep. One of

[1] Annal. d'oculist. t. 88, p. 20, 1882.
[2] Oph. Society of Heidelberg, 28th Session, Aug. 1893.
[3] Trans. Oph. Society of the United Kingdom, vol. xviii, p. 227.

corresponding length in the middle of the shaved supercilia. Two sutures of fine gold or silver wire, each armed with two needles, are introduced at the bottom of the marginal incision, carried up under the orbicularis to emerge from beneath the upper lip of the brow incision, so as to include the frontalis. The tracts of each pair of needles are six to eight millimeters apart. The lid having been drawn up sufficiently, the sutures are tied. The cut in the eyebrow is closed with fine silk sutures; that in the border is left to close of itself.

Objections that have been offered to this procedure are liability of the wire, after a time, to break or to be expelled, and injury to the hair follicles of the cilia. To obviate these features, Bishop,[1]

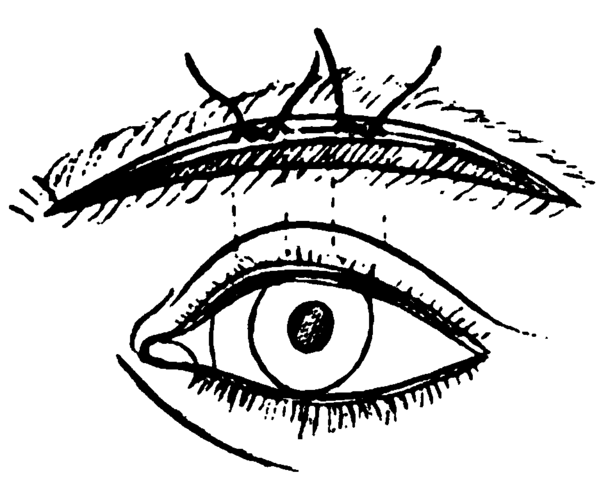


FIG. 105.—Mules.

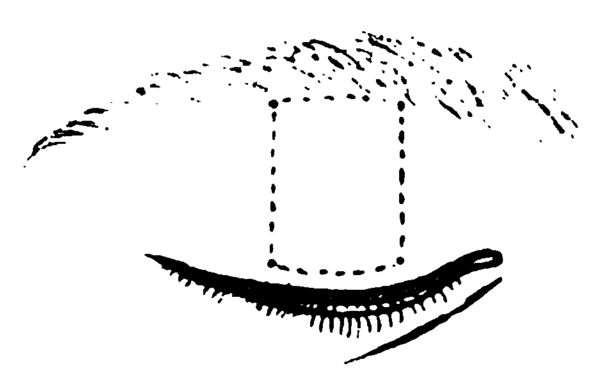


FIG. 106.—Bishop.

of Cambridge, proposed substituting for the wire a fine wove-chain of gold. A single strand of this is threaded into a four-inch abdominal needle. No incision is made (Fig. 106). The needle is first inserted above the supercilia, a little to the nasal side, passed down beneath the orbicularis, close to the tarso-orbital fascia and tarsus, brought out near the cilia, reinserted at the point of exit, carried horizontally along near the free border, brought out external to the median line, reinserted, passed upward, parallel with its downward course, to emerge on a level with the point of first entrance. After drawing up the lid the requisite degree, the needle is put deep into the frontalis where it came out last, plowed horizontally along, and finally brought out where it first entered. The ends are cut off and buried beneath the skin.

Wilder[2] makes a similar operation to that of Dransart, though with

[1] British Medical Journal, Sept. 26, 1903.
[2] Annals. of Ophthalmology, vol. vii, No. 1, 1898.

some important differences and improvements (Fig. 107). The primary incision extends for three and one-half centimeters along the median line of the shaved eyebrow down to the periosteum of the orbital rim. The lower lip is undermined and retracted until the tarsus is exposed. Two double-armed silk or catgut sutures are put into the tarsus, one on either side of its center, and each pair of needles is carried upward a few millimeters apart, but in their course, instead of traversing the orbicularis, as Dransart's do, they are quilted through the tarso-orbital fascia and brought out so as to include the muscular and connective tissue just beneath the upper lip of the brow incision. The sutures are drawn up to the degree desired for the elevation of the lid and tied. The sutures, or ligatures, are left to be absorbed or encapsuled Thus, not only are there two cicatricial cords connecting tarsus and frontalis, but there is also a shortening

FIG. 107.—Wilder.

FIG. 108 —Panas

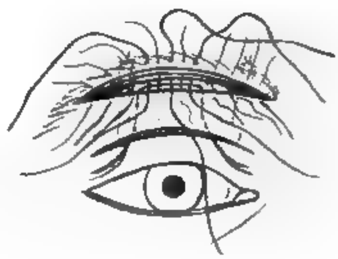


FIG. 109.—Panas.

of the septum orbitale which, in this instance, serves as an advancement of the tendon of the levator (now really the frontalis).

Panas[1] is the author of what has been one of the most popular operative modes for the relief of ptosis. This master in surgery, recognizing the uncertainty of obtaining the desired cicatricial result

[1] Maladies des Yeux, T.xi , p. 140, 1894.

after the mere suture operation, devised a more strictly surgical method, the essential feature of which is, according to its author, the *direct autoplastic fixation of the lid with the orbito-frontal muscle* (Figs. 108 and 109). Panas called the operation *blepharopexy* and it may be described as follows: A lid spatula is put into the upper conjunctival cul-de-sac. A horizontal incision is made midway between the eyebrow and free border of the upper lid, through skin and orbicularis down to the tarso-orbital fascia. From this incision branch two others, including skin only, one on either side, vertically, or slightly inclining outward, till opposite the upper border of the tarsus, when they are given a direction yet more divergent, which, in terminating—the inner one near the punctum, the outer close to the external commissure—is almost parallel with the ends of the first incision. The three points or flaps thus outlined are dissected up. A cut is then made along almost the entire midline of the shaved supercilia, comprising skin and the thick layer of muscular fibres formed by the interlacing of the orbicularis and the frontalis. The bridge of integument between the two horizontal incisions, is tunneled through with a bistoury. The middle flap overlying the tarsus is pushed up through the tunnel and sutured to the superior lip of the upper incision by three stitches. Superficial sutures are put in to close the remaining gaps.

The degree of effect is regulated by placing the primary incision higher or lower, as the case may be, and by the extent to which the buried flap is drawn up. If it is observed, in drawing up the flap, that there is a tendency to ectropion before the sutures are tied, two others are put into the tarso-orbital fascia, one on either side of the middle flap, but not into the skin. These also are passed through the tunnel and united to the upper lip of the brow incision near its extremities. These last are supposed to lift the paralyzed lid in the natural manner, i.e., by giving to it the movement of a rotary hinge, upward and backward, revolving on an imaginary axis, which passes through the two commissures.

The procedure, while successful to a degree, has certain serious drawbacks. The considerable disturbance of the normal relation of the parts, the obliteration of the physiologic sulcus, and the substitution for it of an inverted fold, the covering up of an epithelial surface by a raw one, and the fact that the effect, after all, is obtained

by what amounts to pronounced resection of the skin, are all objectionable features.

Hunt-Tansley Operation.—Devised by Hunt and modified by the late J. O. Tansley, of New York. It belongs in the same group with the Panas operation, and is mentioned here because it has attained considerable popularity in some parts of the United States, particularly in the East. Fig. 110 shows the lines of incision. Two horizontal, parallel incisions, each one-half inch long, are made through the skin, one just below and the other just above the middle of the eye-

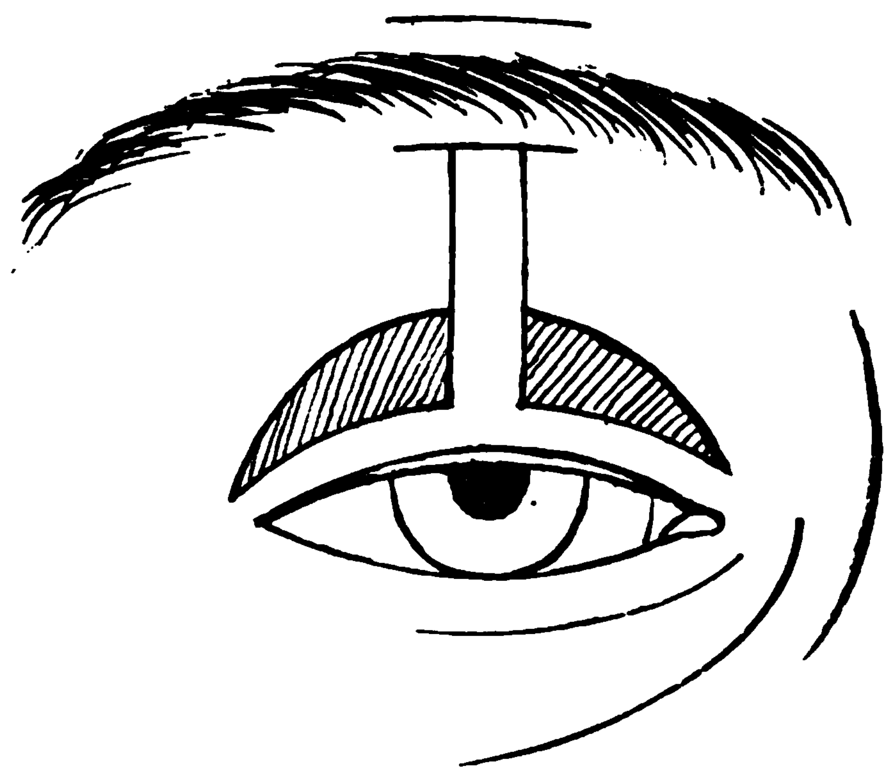


Fig. 110.

brow, and the two are joined by tunneling under. From the lower one two parallel incisions are carried downward, one-quarter inch apart, to within one-eighth inch of the cilia. The vertical strip of skin thus outlined is dissected loose down to its base, a double-armed suture is put into its free end, and it is wrapped round a cylinder of gauze or cotton wet with warm normal salt solution. From the attached extremity of this flap two cuts are made, one outward, the other inward, parallel with the free border of the upper lid, to end at points directly above the canthi—through skin and orbicularis. The canthal ends of these cuts are then joined by an incision made

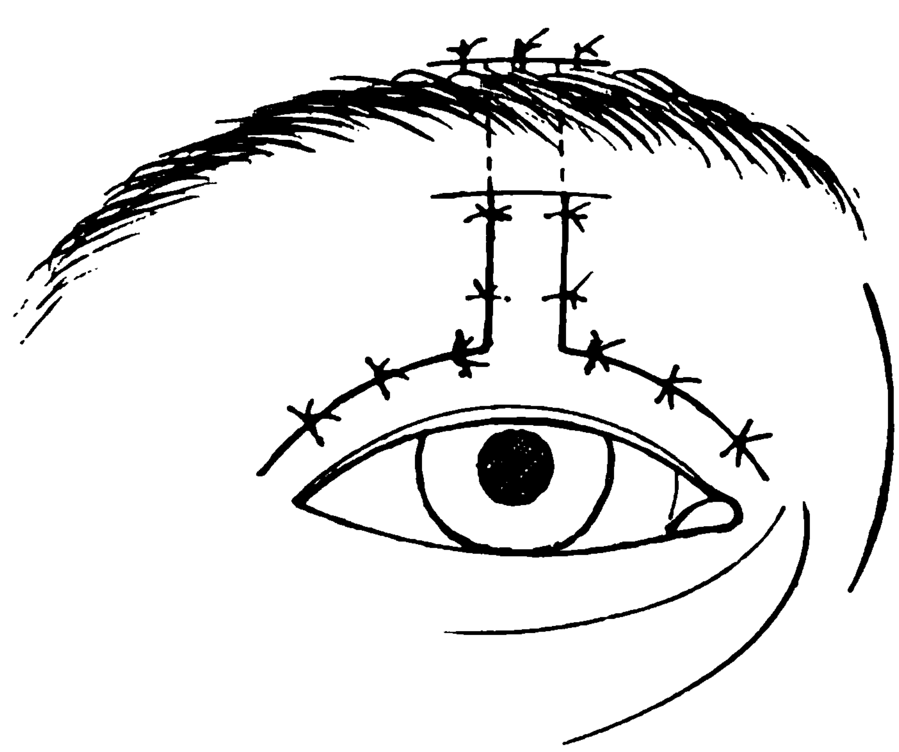


Fig. 111.

along the sulcus which corresponds to the upper border of the tarsus. This also includes skin and orbicularis. The two triangles of skin and the crescent of muscle so formed are dissected out, leaving the tarsus exposed. Now, the needles attached to the

suture in the tongue of skin are passed upward through the tunnel beneath the eyebrow, and the operation is completed by stitches, as shown in Fig. 111.

One of the latest phases of the Vautrin-Darier idea, referred to further back, is the method of *Freeland Fergus*,[1] of Glasgow. By this measure a strip of the occipito-frontalis is, as it were, dovetailed into the affected lid. It is briefly thus: Incision the whole length of the eyebrow down to the tendon of the frontalis. Dissection of the skin, upward for a distance of two inches and downward almost to the free border of the lid. The upper lid of the wound is strongly retracted to expose the frontalis, from which is formed a flap or tongue three-quarters of an inch wide and two inches long. Through this, near its lower or free end, are passed from below two double-armed sutures. These are carried down to the bottom of the pocket made in the lid, brought out, and tied on the skin just above the cilia. The brow incision is closed by interrupted sutures.

This method certainly affords a means of directly coupling the frontal muscle and the lid. Whatever is gained, however, must be through the enhanced power of the muscle, *as a whole*, to raise the lid. For it is not to be presumed that the transplanted tongue will be endowed with separate or special qualities of contraction in the vicarious office thus thrust upon it; nor that the tongue will be free to slide up and down like a muscle in its sheath. The best that can occur is that the lid will be held up by a more or less rigid band extending down from the forehead. And one can readily fancy how such a measure could leave the motility of the tissues about the brow more restricted than they had previously been.

2. **Advancement, or shortening the levator,** by making a fold therein, was first suggested by Bowman in the first volume of Moorfield's Hospital Reports, and first practised by Eversbusch,[2] of Munich (Fig. 112). Under general anesthesia, the plate of Snellen's forceps is placed as high as possible beneath the upper lid and the clamp set. A horizontal incision is made, halfway between the brow and the ciliary border, down to the fascia, the latter exposed by separating the lips, a vertical fold, two and one-half millimeters wide, is picked up in the center of the so-called

[1] Brit. Med. Journal, March, 1901.

[2] Zur Operation der congenitalen Blepharoptosis. Klin. Monatsbl. f. Augenh., Bd. xxi, S. 100, 1883.

tendon, a small, double-armed thread is entered into each side of the fold, carried downward between tarsus and orbicularis, and the needles brought out two or three millimeters apart at the free border. Two other sutures are similarly placed, one at either side. The primary incision is sutured and, lastly, the three pairs of thread ends, projecting from the edge of the lid, are tied over small sections of rubber tubing. Both eyes are bandaged.

Snellen,[1] of Utrecht, is credited with at least two methods to shorten the levator tendon:

FIG. 112.—Eversbusch.

FIG. 113 —Snellen, No. 1.

1. **By Resection.**—After exposing the fascia in the usual way, by an incision parallel with the upper lid border, a cut was made transversely through it (Fig. 113). Two or three catgut sutures were passed through the upper edge of the tarsus from the front; the cut end of the tendon was lifted, the sutures passed through it, high up, from the back, a portion was resected commensurate with the amount of shortening desired, the threads were tied and the skin wound closed. Fuchs makes a resection somewhat similar to the above.

2. **By tucking without any incision,** either of the skin or of the conjunctiva,[2] by means of burrowing sutures (Fig. 114). At the center of the insertion of the levator a thread is made to pass through skin, tarsus, and conjunctiva. Then, with the lid everted, it is carried upward between the conjunctiva and the fascia, again brought out through the skin, the latter is lifted, the needle inserted at about the same point whence it has just emerged, passed down beneath the integument, and brought out where it first penetrated. Two others are thus inserted, one on either side of the first, and their

[1] Report of the German Oph. Society at Heidelberg, 1883

[2] Trans. Oph. Society of the United Kingdom. Oph. Review, Nov. 14, 1889.

ends are knotted over bits of drainage tubing. Gruening, of New York, had already made practically the same operation, though with the aid of the ordinary skin incision.

De la Personne,[1] Angelucci,[2] and others have also modified the Eversbusch procedure.

Resection of the tarsus as a measure for the cure of ptosis was revived by Sir William Bowman, as an adjunct to resection of the orbiculáris, as practised by his friend von Graefe. At a glance this method would seem to stand in a class by itself, yet virtually

FIG. 114.—Snellen, No. 2.

FIG. 115. Gruening

it is but an advancement of the muscles normally concerned in lifting up the lid. Bowman removed a portion of the tarsus and the contiguous portion of the orbicularis. Galezowski went still further and excised a strip that included the whole thickness of the lid. A well known modification of the Bowman operation is that of Gillet de Grandemont.[3]

Gruening,[4] of New York, has, for some time, employed, with satisfactory results, a modified form of De Grandemont's method (Fig. 115). He uses it for almost any variety of ptosis, and performs it as follows: An incision is made through skin and orbicularis muscle, parallel with, and 4 mm. from, the free border. Skin and muscle are dissected up and retracted. A portion of the bared tarsus, comprising its whole width, from inner to outer canthus, and the whole thickness, including the adherent conjunctiva, is cut out. The vertical diameter of the excised strip varies with the degree of ptosis, though it is always wider in the middle, where it may measure 7 mm., tapering almost to a point at either extremity. The tarsal wound is

[1] Archiv d'opht., vol xxiii, p 497, 1903.
[2] Archiv di Ottala. p. 489, 1904
[3] Bull. et mém de la soc. Franc. d'opht., 1891, p 80.
[4] New York Eye and Ear Infirmary Reports, 1904.

closed by three double-armed sutures. One needle is passed horizontally through the tarso-orbital fascia, then both needles are passed downward, through the remnant of tarsus, and brought out at its free border, behind the lashes, where the suture is knotted. Thus the lips of the tarsal wound are brought into apposition, and the lashes are given a horizontal direction. The skin opening needs no sutures.

3. **Joining the Tarsus with the Superior Rectus.**—In cases of ptosis not complicated with paralysis of the superior rectus, the late Dr. Parinaud[1] (Fig. 116), after having everted the upper lid, made a horizontal incision one and one-half centimeters long, including the conjunctiva, and the upper border of the tarsus at its

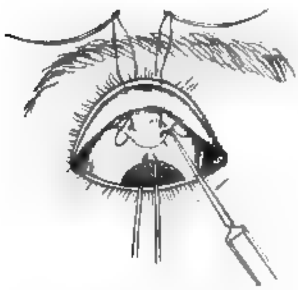


FIG 116 Parinaud

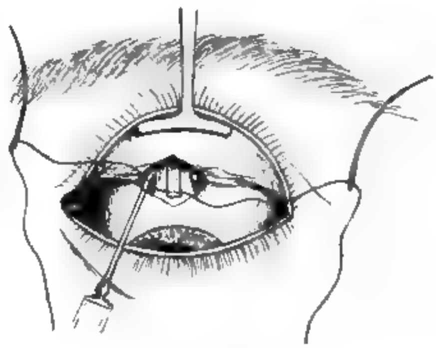


FIG 117 —Motais.

middle; seized the conjunctiva with fixation forceps near the upper corneal limbus, and rotated the globe far downward; opened up the conjunctival incision, and exposed the tendon of the rectus, raised it with forceps, passed a double armed suture beneath it, including its aponeurosis. Then each of the needles was passed upward, through the adjacent conjunctiva, thence through the levator tendon, downward between tarsus and skin, and brought out, seven millimeters apart, at the free border. They were here tied over some soft substance, and taken out after four to six days.

Motais,[2] of Angers, has given an ingenious and highly approved ptosis operation, which embodies the Parinaud principle:—a

[1]Ann d'oc, 1897, t cxvii, p 12

[2]Bull et mém de la soc, d'opht, de Paris, Nov., 1898

meridional incision of the conjunctiva, beginning over the center of the insertion of the tendon of the superior rectus, or about seven mm. from the upper corneal limbus—is extended through the retrotarsal folds, to end at the convex edge of the tarsus (Fig. 117). This is opened and retracted, so as to plainly reveal the tendon, which is then lifted upon a strabismus hook. The hook is worked back and forth in such a manner as to loosen the tendon from its surroundings. A fine, but strong braided suture, armed with two curved needles, is passed in and out through the tendon near its insertion, so as to include its middle third. To give the thread a solid hold, it has been suggested that it be at once tied. This, however, is apt to complicate matters in removing it. With knife and fine blunt-pointed scissors, a tongue is formed of the portion embraced by the thread, its free extremity cut flush with the sclera, and the other left at the union of the muscle fibres; i.e., it extends the entire length of the tendon. It must be seen to that the thread is firmly fixed in the end of the tongue. If there be any doubt on this point, the tongue is folded upon itself and the suture again passed through. The surgeon places the tip of his index behind the inverted lid as a guide, and, with the scissors, makes a pocket between the anterior surface of the tarsus and the fascia of the orbicularis. This pocket is wide enough to receive the tongue and reaches almost to the border of the lid. The needles are passed into the pocket, through at its bottom, to emerge on the skin surface of the lid, near the cilia, about 4 mm. apart, and are tied over a roll of antiseptic gauze (Fig. 118). The conjunctival opening is closed with fine sutures. It were well to have these of catgut and leave them to be absorbed, thereby obviating any disturbance of the lid at the end of two or three days. The thread attached to the tendon is removed at the end of 5 days to a week.

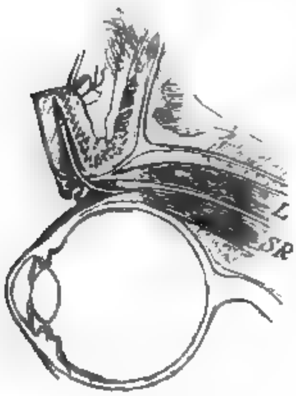


FIG. 118.—Motais.

Motais' procedure is founded upon the synergy of action existing between the superior rectus and the levator. It follows, theoretically, that, as a result of the engrafted tendon, natural movements are

imparted to the lid. In other words, that in looking up, for example the lid does not lag behind.[1]

FIG. 119 Beard's method for ptosis. Front view.

For a number of years past I have practised, with most gratifying results, a method that combines the principles of the Anagnostakis-Hotz entropion operation, the tucking of the levator tendon of Eversbusch, and a little of the suture arrangement of Pagenstecher[2] (Figs. 119 and 120). A lid horn is put beneath the upper lid. An incision is made along the sulcus, rather in its upper slope than exactly in its bottom, through skin and muscle, and extending the whole length of the tarsus. The divided fibres of the orbicularis are undermined, both above and below, exposing the tarsus and its suspensory ligament. Four curved, one-inch-long needles, carrying two sutures (i.e., double-armed) of No. 3 braided silk, boiled in vaselin-paraffin, are in readiness. Each needle is passed through the lower flap near its edge, from within outward, then through a horizontal fold of the tarso-orbital fascia—really the tendon of the levator—picked up by broad-jawed fixation forceps, thence upward, quilting, or, as Wilder says, "gathering" the septum orbitale, and brought out well above the supercilia.

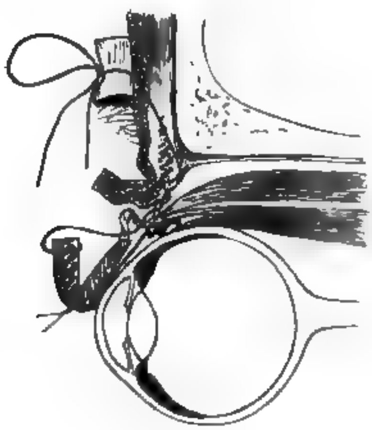


FIG. 120.—Beard's method for ptosis. Sectional view.

A handy way of picking up the deep fascia at any chosen point,

[1]For further remarks on the Motais operation see *Summary* at end of chapter

[2] Oph. Record.

is to first dig the point of the needle in somewhat, in order to lift the tissue, then grasp it, in the horizontal sense, with the jaws of the forceps. The threads are so spaced that the loop left lying inside the lower flap is about six to eight millimeters long, and its middle marks the junction of the middle and end thirds of the tarsus. At first I put the needle through the lower flap of skin and muscle from the cutaneous surface, but soon found that this tended to fold the flap horizontally, and to turn its edge outward.

The manner of tying the sutures is important. One pair of thread ends is held between the left thumb and index, while, by means of small, mouse-tooth forceps, the edge of the lower flap is seized between the corresponding threads, pulled up and rolled backward, and placed in apposition with the tarso-orbital fascia just where the thread enters the fold therein. The two ends of thread are, meanwhile, drawn up pretty well, but not tightly, and tied in a single surgical knot over a short cylinder of firmly rolled gauze or absorbent cotton. The same is done relative to the flap and other suture. Before finishing the knots, it is seen to that the edges of both skin flaps are directed *backward;* in other words, not coapted one with the other, but that both are in contact with the broad ligament of the tarsus. In this way the resulting cicatrix is completely hidden by a normally placed and normally appearing sulcus.

Lastly, the sutures are tightened as much as is needed for the desired effect, and are tied in bowknots. In the extreme cases it will be impossible for the patient to close the lids so long as the sutures are in. As this is for only two or three days, during which time a carefully applied dressing and bandage is worn, there is no danger to the cornea. Nothing more is expected of the sutures than to hold the operated parts in their new relations until primary union is assured; that is to say, they are not left in position to suppurate or to cut through. The tension of the threads may be altered at any time within twenty-four to thirty-six hours, if one wishes to qualify the primary results, by merely undoing the bowknot and loosening or tightening the other one, as the conditions demand. In removing the sutures, the rolls over which they are tied are pulled smartly up, both threads are cut off close to the skin and withdrawn by seizing the loop below. In this way no soiled portion passes through the tracks.

I consider the *Hotz idea*, as embodied in this procedure, to constitute, probably, one of its most salient advantages, and, taken all in all, theoretically as well as practically, it seems to possess some of the best points of other ptosis operations, and eliminates some of their worst faults. It is adapted to all the ordinary forms of ptosis, the degree of effect being governed by the height of the fold made in the broad ligament of the tarsus, its distance from the upper border of the tarsus, and, in some measure, by the distance of the primary incision from the free border of the lid.

Narcosis is employed only when necessary. Cocain solution injected into the skin is less of a help than a hindrance. It is usually dropped into the open wound, but it is of doubtful benefit.

Summary.—In the foregoing chapter an attempt has been made to give, by describing example ptosis operations, an idea of some of the many different methods, and to illustrate the guiding principle in each instance. In the primitive operation of excising a segment of skin mere shortening of the lid was the aim and the end. Naturally, this can only be applicable to cases characterized by an actual redundance of integument, i.e., *cutaneous ptosis*, or *blepharochalasis*, for, in general, the lids of ptosic subjects are already too scant. This is particularly true of congenital ptosis, in which the lids are short, flat, and devoid of any sulcus in the skin. In the operation of von Graefe the object was the weakening of the antagonist of the levator or the orbicularis, and was manifestly faulty in the premises. The Bowman-Gillet de Grandemont methods are similar to von Graefe's in that they really amount to subcutaneous shortening of the lid; but they are an improvement in so far as they effect an advancement of the elevators of the tarsus. As to the palpebro-frontal ligament of Dransart, as represented in the original operation and in those of Mules, Bishop, Wilder, and others, there is no denying that the results are positive, but they are mainly due to shortening. There is no definite advancement of the normal elevators, the lifting of the lid is relegated almost wholly to the frontalis, which is but a poor substitute, and besides, a foreign body is left in the tissues; not the least objection to this is that it is sometimes extruded. They would seem to be superior to those other methods that are employed for putting the lid in more direct connection with the frontalis, whereby tongues or strips of

muscle are transplanted. The frontalis owes its power of lifting the eyebrow to the fact that its attachment is essentially to the skin; hence, procedures that call for deep or extensive incisions and other traumatism in the superciliary region must result in scars that inevitably limit the natural movement of the parts. Then, too, these engrafted fragments will atrophy, and the effect obtained will diminish with the lapse of time. The palpebro-frontal ligaments are peculiarly suited to cases in which both the levator and the superior rectus are powerless. In the mode of Pagenstecher, of gradually tightening ligatures, the object was the coupling of the lid to the frontalis by means of cicatricial cords, and looked to a determinate result through a most precarious and irregular medium, viz., the exciting of an inflammatory or suppurative process. In the procedure of Eversbusch and his followers the object sought is the shortening or advancement of the levator, and its futility *as a systematic, all-around process* would appear to lie in the fact that the muscle concerned is, in the great majority of cases, either absolutely inert or of extremely insignificant force. While, therefore, the sphere of these measures is thus limited, they are theoretically suitable only for a certain small number of cases in which the levator is fairly potent, as in trachomatous ptosis. But, as a matter of fact, they have a much wider range of usefulness, of which more anon. The Motais-Parinaud measures are happily imagined and rest upon a physiologic as well as a scientific basis. Yet they depend for their success upon the integrity of the superior rectus; and in a large percentage of cases of ptosis there is paralysis or marked insufficiency of the muscle. Theoretically considered, the very pronounced drawing forward of the superior rectus that would be requisite for the correction of an extreme ptosis by these methods would result in undue tension diplopia and, possibly, vertical squint. They would find their best application, then, to the lower grades of ptosis in which the superior rectus is of normal strength. According to Terson,[1] of the considerable number of operations of this kind that have been recently performed, some have been followed by good results, and others not only by failure, but by corneal complications—the latter even leading to anterior staphyloma. Moreover, the eye is said to be more prone to remain open

[1] Encyclopédie Française d'ophtalmologie, vol. v, p. 498, 1906.

during sleep after the Motais-Parinaud methods than after other operations for ptosis.

Shoemaker, of Philadelphia, in the *Annals of Ophthalmology*, Oct., 1907, makes certain pertinent remarks as to the Motais operation from the theoretic standpoint. For instance, he says, "Motais claims to supply a perfect physiological substitute for the levator by such a transplantation of the superior rectus tendon. This is not actually the case, but the lid after the Motais operation is held in its new position by anchorage to a fixed point on the eyeball, so that there can be no elevation or movement of the lid through the transplanted portion of the superior rectus independent of the eyeball." Did the writer of these words bear in mind how slightly, even in the normal eye, the levator can act independently of the elevators of the globe? Shoemaker further says that the tongue or slip of the superior rectus is perfectly inextensible if made of tendon, as was the intention, and that if made ten millimeters long, as Motais specified, it would reach into the muscle and be apt to part upon the slightest tension. Yet he thinks the possible effect to be derived from the operation is great, and when little or no effect is obtained he believes the cause of the failure lies in transplanting the slip among the fibers of the orbicularis, instead of securing it to the tarsus, and that this is particularly apt to occur when the stitch is tied on the skin, as the tendon is then drawn away from the tarsus. To be sure that the slip is attached to the tarsus he would suggest the open method, as follows:

The first stage of the operation remains unchanged except that in passing the double-armed thread through the prepared tendon slip, pass the needles from above downward, placing the loop on the upper surface. Then make a horizontal incision through the skin of the lid and the orbicularis muscle down to the tarsus a little below its upper margin. Undermine the orbicularis fibres by pushing them upward or backward, exposing the tarsus to its upper margin. Buttonhole Müller's muscle and the conjunctiva and through this opening carry the sutures with the piece of tendon, and fasten the latter directly to the surface or edge of the tarsus precisely as we do the tendon to the sclera in an ordinary advancement. Having dipped each needle into the tarsus and brought tarsus and tendon slip into direct contact, restore the orbicularis fibres, carry

the needles through them and the skin, and tie. Close the wound in the lid with two or more stitches.

He thinks permanent paralysis of the superior rectus is not necessarily a contraindication to Motais operation, but may be rather an advantage, and he sees no reason why, in such a case, the whole tendon should not be transplanted and put to some use. A positive contraindication would be a thin, poorly developed superior rectus.

The laying bare of the tarsus, as proposed by Shoemaker, doubtless has its advantages. Not the least of these being the greater facility it affords for the definite and precise disposition of the transplanted tongue. My colleague Wilder has been the first, I believe, to put Shoemaker's idea into execution. This he has done of late in several instances, and expresses himself as well pleased with the outcome. In addition to adopting Shoemaker's proposal, Wilder has added a feature of his own. He reasoned, and rightly, that the little tongue gives hardly more than a single point of support to the lid, and even thought that he observed, in a case that had been operated upon by the Motais method, that the free border of the upper lid showed a sort of notch corresponding to the point of attachment of the tongue. To avoid this, as well as to serve as auxiliaries to the delicate tongue in holding up the lid, he places a slowly absorbable suture in the ligament of the tarsus on either side of the buttonhole through which the tongue is drawn, and in such a manner as to slightly fold said ligament. He thus combines with the Motais measure something of that of Eversbusch—or a slight shortening or tucking of the levator tendon.

Objections to, or criticisms of, a measure on purely theoretical grounds, no matter how cleverly conceived nor how logically argued, are not necessarily valid nor conclusive. Many reports have been made in ophthalmic literature of most excellent results obtained with the Motais operation. Notable among those made in this country is that of H. D. Bruns, of New Orleans.

The present writer has performed it in eight cases. Two of these were trachomatous ptosis of high degree. In one the lid had fallen completely. Since the upper borders of the tarsi had undergone trachomatous degeneration, they were excised at the same time, thus allowing the anchorage of the tongue to be made at the middle

of the tarsus instead of at the upper border. The outcome of these cases was so singularly gratifying that I wondered if it were not best oftener to combine the operation with a slight excision of the tarsus. I have recently seen a recommendation to that effect by a French author. In the operations just referred to it was necessary first to make a free canthotomy, in order the better to manage the upper lid, there having been considerable atrophy of the conjunctiva.

In addition to the two cases just mentioned, my eight included five of congenital ptosis and one from traumatic paralysis of the levator. The results in all of them are far and away the best I have ever obtained in this affection. As concerns the last case operated it was feared for a time that either the tongue had broken, or the suture had pulled out of it, but this fear proved to be groundless. The manner in which the free border of the upper lid keeps out of the way of the pupil, as the subject looks further and further upward, is truly beautiful to contemplate. As regards annoying diplopia, upward squint, inability to keep the lids closed during sleep, etc., I have not observed any of these. It is true, however, that one can, soon after the operation, demonstrate hypertropia. According to this phase of the subject, one would naturally conclude that cases of bilateral ptosis, having both eyes operated, would be more likely to escape this complication than would the monolateral ones.

I find that in congenital ptosis the lack of power in the superior rectus is main y due to non-use, for these subjects have no occasion to rotate the globe upward. By careful examination it can usually be demonstrated that there *is* limited function in the muscle. No matter how little there is, the Motais operation is the one, in my opinion, that should be chosen. After the lid is once raised the superior rectus develops more and more its proper function. Herein lies the explanation of a unique and most gratifying feature of the Motais method, viz., the constantly increasing enchancement of the effect for weeks and even months after the operation.

A little study is invited of the accompanying drawing (Fig. 121), which is a tolerably accurate representation, in vertical, median section, of the tissues concerned in the surgery of ptosis. This will demonstrate that any measure which folds or in any way shortens the broad ligament of the tarsus, not only advances the levator and

Müller's muscle, but also tightens up, or *advances*, the levator portion of the tendon of the superior rectus. It follows that, *as single, constant measures*, the class of operations treated of under the second category, viz., *the advancement of the natural elevators*, are, perhaps, those deserving of the greatest confidence. Granting that those in the first class—*the linking of the lid to the frontalis*—are as effective

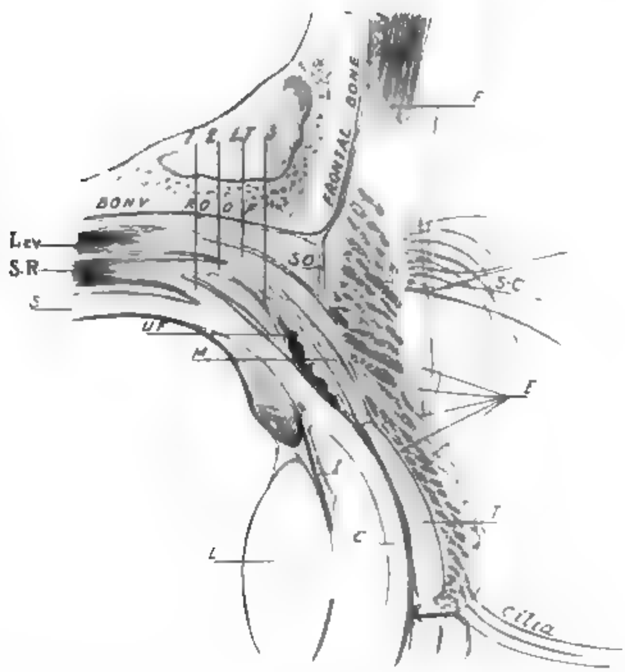


FIG. 121.—Lev., Levator muscle. S.R., Superior rectus muscle. S, Sclera. U.F., Upper fornix. M, Muscle of Müller. I, Iris. C, Cornea. L, Lens. 1, Scleral portion of superior rectus tendon. 2, Levator portion. 3, Conjunctival portion. L.T., Levator tendon. S.O., Septum orbitale. F, Frontal muscle. S–C, Super-cilia. E, Expansions of the levator tendon. T, Tarsus. The lids are represented closed.

in lifting up and holding the lid, the feat is accomplished in an unnatural manner; that is, the lid is pulled straight up, not rolled back and up, normally, like the visor of a helmet; moreover, the forehead is corrugated in the act, thus adding another deformity. We have noted the limitations of those in the third class.

All who have had much experience in this branch of ophthalmic

surgery will agree that the results of ptosis operations, taken all in all, are far from brilliant. "It is only with precise appreciation of the peculiarities of the individual case, that one may hope to succeed in this delicate, and special surgery of the lid" (Terson). A correct diagnosis as to the *character* of the ptosis and a nice estimate as to its *degree*, are pre-requirements to a fortunate issue. The high degrees of congenital ptosis, with inert superior rectus, are the most difficult with which to contend. It is in these that, according to the writer's observation, the greatest good is to be looked for from those surgical measures that do not rely for their success upon a single feature or principle, but upon *a well-considered union of two or more*. In this manner one is not obliged so to exaggerate a particular step as to risk, for example, the production of unsightly and harmful lagophthalmos, but is enabled to obtain a maximum effect with a minimum disturbance of any one of the several parts involved. For the milder forms of partial ptosis all the measures that have just been described readily give satisfactory results in good hands and in well-selected cases. After all, it is here, just as with surgery in general, that subtle something known as *personal equation* is a tremendous factor. A chosen few seem to be lucky, whatever the methods they select.

CHAPTER VII.

ENTROPION.

Entropion, or turning inward of the lid upon the globe, is of two kinds—functional and organic. The evil results of the condition have reference, mainly, to the damaging effects upon the cornea and conjunctiva caused by the contact of the misplaced eyelashes, or trichiasis; though the deformity, and the pressure, and the rubbing of the warped and shrunken tarsi upon the globe, in the worse forms of organic entropion, are alone sufficient reasons for surgical intervention.

Functional or spastic entropion usually concerns the lower lid only, and occurs most often in elderly persons in whom the palpebral integument is lax or superabundant. It is then known as *senile entropion*, and a common cause is the wearing of a bandage. Not infrequently, however, it affects the lower lid of younger subjects, when it is accompanied by inflammations of the skin and of the conjunctiva. This form of spasmodic turning in has been called *acute entropion*. Whatever the cause or the age of the individual, they are treated about alike; that is, for the transient or less obstinate varieties simple mechanical means are successfully employed, and for the more stubborn, surgical measures are required.

If from bandaging, and it is not practicable to leave off the dressing, a strip of rubber adhesive plaster five or six centimeters long, by one to one and one-half wide is applied vertically. About one centimeter of the upper end is first made to adhere just below the cilia, pulled downward slightly, to draw the free border away from the eye—not so much as to produce a decided ectropion—then fastened throughout the rest of its extent. If there is any lacrimation, the tears soon loosen the plaster, in which event it is better to gently evert the lid and to paint flexible collodion over the region of the lower half of the orbicularis, taking care to close the eye and otherwise protect it from the ether.

A more efficient way is to cut a small strip of gauze or other suitable fabric, lay it on the part, and glue it down by smearing on the collodion (Fig. 122). As with the plaster, the upper end is made fast first, allowed to dry, then drawn down, and the whole made to stick. If the entropion persists in spite of the continuance

FIG. 122. Applying collodionized gauze for spastic entropion of lower lid.

of such treatment for a reasonable time after the exciting cause has been removed, some form of operation is resorted to as a choice of two evils; for, while lid abscess and even phlegmon of the orbit are known to have resulted from the sort of surgery in question, the trifling risk therefrom, as compared with the sure harm to the cornea and conjunctiva that will follow the prolonged friction of the lashes,

is not to be considered. If the entropion be still purely spastic, one of the safest and most effective remedies is canthoplasty, with free division of the external canthal ligament—the *cantholysis* of Agnew—as described in its proper place.

One may also have recourse to one of the suture operations. These, of which a number have been devised, consist in inserting a thread or a series of threads, vertically in the tissue of the lower lid, that through the tying or through the consequent cicatrizing will correct the entropion. The forerunner of most of them was that of Hippocrates, who passed a ligature through a horizontal fold of the skin just beneath the free border, and allowed it to suppurate out. Gaillard[1] entered from one to three curved needles, carrying silk thread into the skin just beneath the lashes, that penetrated to the tarsus, followed its anterior surface, thus including skin and orbicularis, and emerged, straight below, some fifteen millimeters or more from the point of entrance, according to the degree of redressal required. They were tied tightly and left till their spontaneous release.

Arlt[2] modified Gaillard's method (Fig. 123) so that, in accordance with present ideas, it might be thus described:

Two No. 3 braided black silk sutures, previously boiled in vaselin-paraffin and otherwise aseptically prepared, are needed, each of which is armed with two curved needles. With left finger and thumb a horizontal fold of the skin large enough to correct the defect is picked up beneath the affected lid. One pair of the needles is made to penetrate the base of the fold on the same level, two or three millimeters apart, and about the same distance (three millimeters) from the free border—one on either side of the junction of the middle with the outer third of the lower lid. They are passed downward between tarsus and muscle, and brought out as in the Gaillard operation. The other pair is similarly introduced, astride the junction of the middle and inner thirds of the lid. In tying, a cylinder of some soft material is placed beneath both knots and under both loops, whilst a large probe or other round instrument is pressed against the tarsus to make it cave inward. A bandage is applied until the sutures are removed at the end of forty-eight hours.

[1] Bull. de la Soc. med. de Poetiers, 1844.
[2] Die Krankh. des Aug., iii, S. 368, 1856.

Snellen's[1] Sutures.—The eye is cocainized. The edge of the lid is seized with a pair of T forceps, or with the fingers, and everted enough to open the cul-de-sac, in the bottom of which the needles are started (Fig. 124). One needle of a double-armed suture is here passed (convexity downward) directly through the whole thickness of the lid, just external to the lacrimal punctum, and the other

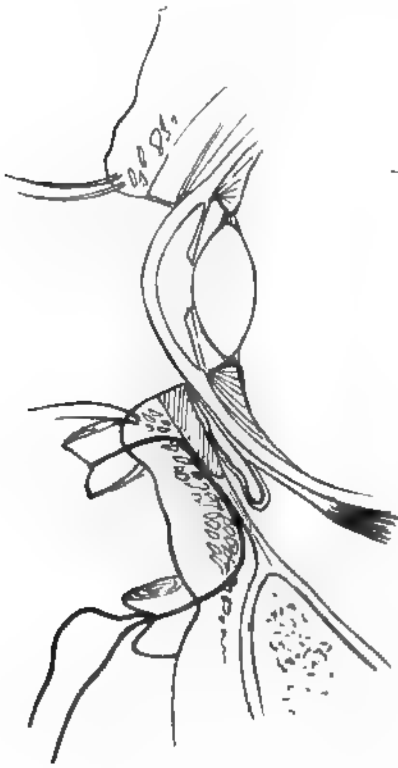


FIG. 123.—Arlt's suture for entropion.

FIG. 124.—Snellen's suture for entropion.

through about four millimeters further outward, while the resultant loop is drawn down into the fornix. The point of each needle is then inserted at its place of exit from the skin, passed upward beneath the latter—not beneath the muscle—one parallel with the other (their convexities backward), and brought out two millimeters below the cilia. One or two other threads are placed in precisely the

[1] Cong internat. d'oph., Paris, 1863.

same manner. The lid is turned outward, over a round instrument of some kind, and the sutures are tied over cylinders and left in three or four days, the eye being bandaged meanwhile.

Stellwag's sutures (Fig. 125), like Snellen's, began by loops at the bottom of the lower fornix, but instead of passing first through the lid, were directed up and forward between the tarsus and the orbicularis, to emerge from the skin near the cilia.

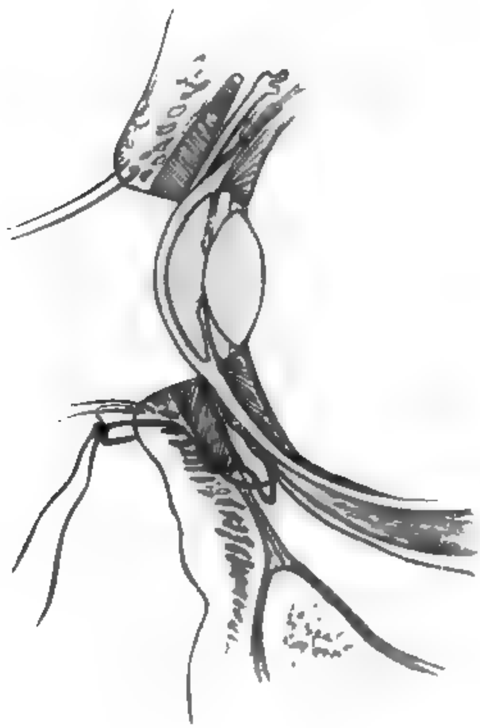


FIG. 125.—Stellwag's suture for ectropion

Graefe,[1] in some cases of spastic entropion, picked up a small vertical fold of skin, two or three millimeters wide, near the center of the free border, passed a thread through its upper end, tied it, and cut one end off short. This was repeated directly below, over the rim of the orbit, and the two long ends of thread were

[1] Heidelberg Cong., 1868.

knotted over cotton or gauze. One or more were employed as the case demanded.

The excision of a strip of the extreme border fibres of the lower section of the orbicularis, through an incision close to the cilia, is effective and proper for the relief of recent spastic entropion and is sometimes successful after the simple sutures have failed.

The simple excision of a section of skin in the form of ellipses, triangles, etc., of greater or lesser extent, after the fashion of the ancients, is still practised, to a limited extent, for functional entropion as well as for the cicatricial variety. The opening is either closed by suturing or is left raw to heal by granulation (Desmarres).

Another primitive cure is linear cauterization of the skin along the border. Both these measures are irrational and fogyish. The mere fact that they do away with the entropion in most instances does not render them free from censure, and they may be easily pushed to such an extreme as to cause the substitution of one blemish for another, such as lagophthalmos, unseemly scars and ectropion. It is doubtful if sheer redundance of skin is ever the true cause of entropion, but it is certain that the removal of it will pull the lid away from the eye—so might many an odd contrivance.

ORGANIC OR CICATRICIAL ENTROPION.

UPPER LID.

This form, unlike the functional, consists not so much in the *malposition* as in the *malformation* of the lid, the chief factors in which are the warping of the tarsus, through the transformation of this body into cicatricial tissue, and the atrophy and consequent shrinkage of the conjunctival sac.

The *causes* are diseases such as chronic inflammations and ulcerations, beginning in the conjunctiva, the results of infection, burns, and other injuries. The greatest of all agents, both as to its capability and its frequency, in the production of cicatricial entropion is chronic granular conjunctivitis, or trachoma. The countries bordering on the Mediterranean Sea have from the times of their earliest history been peculiarly subject to this affliction, hence,

they early began to devise surgical means for the relief of trichiasis, which is the greatest evil of entropion.

This form differs in another respect from functional entropion, viz., that it more generally concerns the upper lid. In dealing with entropion from trachoma, therefore, it is well to keep in view the manner of its production; in other words, the clinical characteristics of the disease which produces it, as constituting the rationale for its best and most progressive surgery. The features that have a special bearing may be stated thus:

1. **Principal Seat.**—The upper conjunctival fornix.

2. **The intense photophobia,** which is the earliest factor in the causation of entropion. Through it an abnormal development of the orbicularis ensues, especially of the palpebral or inner zone of the muscle which remains after the acute stages of the disease have passed. By its action the tension of the lids upon the globe becomes excessive, the friction is increased, and the protecting, sharp, inner angle, containing the *musculus ciliaris of Riolani*, disappears, the free border becomes *whetted* down, by absorption, to a feather edge, and the underhanging skin contains the lashes.

3. **The atrophy** of the entire conjunctival sac and the whole of the tarsi that are responsible for the shrinkage and distortion of these parts—a process that, once well under way, seems never to come to an end until death.

Nos. 2 and 3 are, probably, both concerned in the bringing about of the varying degrees of ptosis that are so often associated with entropion. The levator gradually yields to the prolonged antagonism of the powerful orbicularis and to the obliteration of the upper fornix, through atrophy of the conjunctiva, and becomes permanently disabled.

Incipient, or slight cicatricial entropion, when the cause of it is no longer active, can rarely be corrected by one of the operations described for the functional kind. Here tissue has been destroyed that must usually be replaced.

The first important operation of which there is a definite account is that described in the medical works of Ætius, written in the sixth, and those of Paulus Ægineta, in the seventh century of the present era. Briefly, it was as follows: The free border was divided vertically, from canthus to canthus, into two leaves—the

anterior, composed of the skin holding the cilia and their follicles; the posterior, of the tarsus and conjunctiva. An ellipse of integument, the length of the palpebral fissure, was removed just above the roots of the lashes, and the latter, with their loosened bridge, slid up and fixed to be out of the way. This is the identical operation that was revived by G. Jäsche[1] and that, modified by v. Arlt,[2] had such a tremendous though ephemeral vogue, under the name of "Verabschiebung des Wimperbodens nach Jäsche-Arlt," or, in English, *transplantation of the eyelashes* (Figs. 126 and 127).

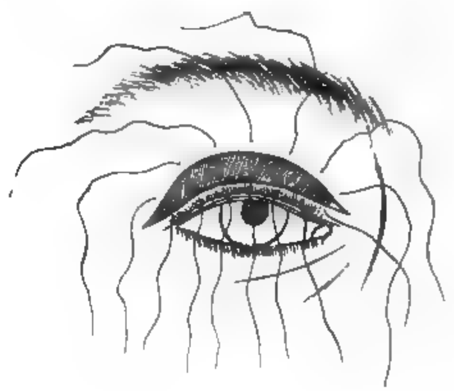


FIG. 126 — Jäsche-Arlt, No. 1.

The great faults of this procedure were: (*a*) want of a fixed point above for the upper edge of the flap; (*b*) lack of support from below, so that the cilia gradually descended until they again rested on the eyeball; and (*c*) no attention was paid to the incurvation of the tarsus; nor (*d*) to the atrophy of the conjunctiva and restoration of the free border; (*e*) to the relief of lid tension; (*f*) to drawing up the loose underhang of the cilia; nor (*g*) the counteracting of the tendency to ptosis.

FIG 127.—Jäsche-Arlt, No. 2.

The need (*a*) was found by Anagnostakis,[3] of Athens, who chose the upper border of the tarsus (Fig. 128). He made a cutaneous incision the length of the tarsus, only three millimeters from the free border, opened it up, and resected a strip of the orbicularis overlying the upper border of the tarsus, and to the

[1] Med Ztg Russlands, No 9, 1844.
[2] Graefe-Saemisch, Bd. iii, 1874.
[3] Annal d'oculist t xxxviii, p. 5, 1857.

latter stitched the lower lip of the skin incision. The upper lip was not included in the sutures. This method failed in all the other requirements save (*a*).

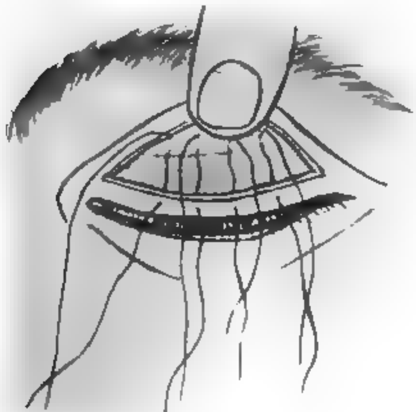


FIG. 128.—Anagnostakis

Hotz,[1] of Chicago, modified this proceeding by making the primary incision higher up and parallel with the upper tarsal border, to give a normal sulcus with the scar at its bottom (Fig. 129). He passed the sutures through the upper lip of the skin incision also before tying, and, most important of all, insisted upon the resection of the lower fibres of the orbicularis—thus partly fulfilling indication (*e*). To Hotz is really due the credit of perpetuating the principle adduced by Anagnostakis, and which is so necessary a part of the advanced entropion operation. Moreover, as regards the inception of the idea, Hotz owes nothing to the Greek surgeon.

The first to see, and partly to supply, the second want—support from below—as well as the first to make marginal blepharoplasty, was Spencer-Watson.[2] This surgeon, after splitting the lid border as per the old Greek method, made as if to remove the ellipse of skin, but left the outer end attached, as he did also the inner end of the cutaneous bridge containing the cilia, as nourishing pedicles. He then caused the two flaps thus formed

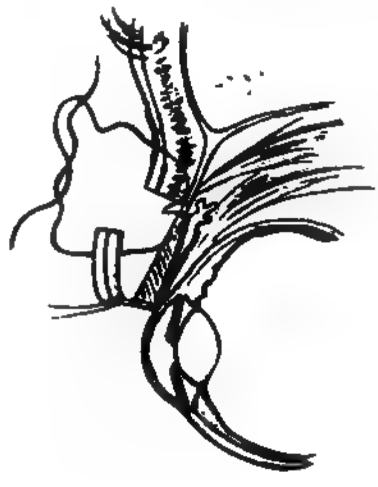


FIG. 129.—Hotz. Border fibres excised.

[1] Archives of Ophthalmology, vol. viii, p. 249, 1879.
[2] Med. Times and Gaz., vol. xlix, 1874.

to exchange places, and fixed them in their new relations by fine sutures (Fig. 130).

Gayet[1] split the free border and dissected up the long strip of skin, with external pedicle, which he transplanted back of the cilia without sliding up the skin containing them, thus partly meeting requirement (*d*) —or restoration of atrophied tissue (Figs. 131 and 132).

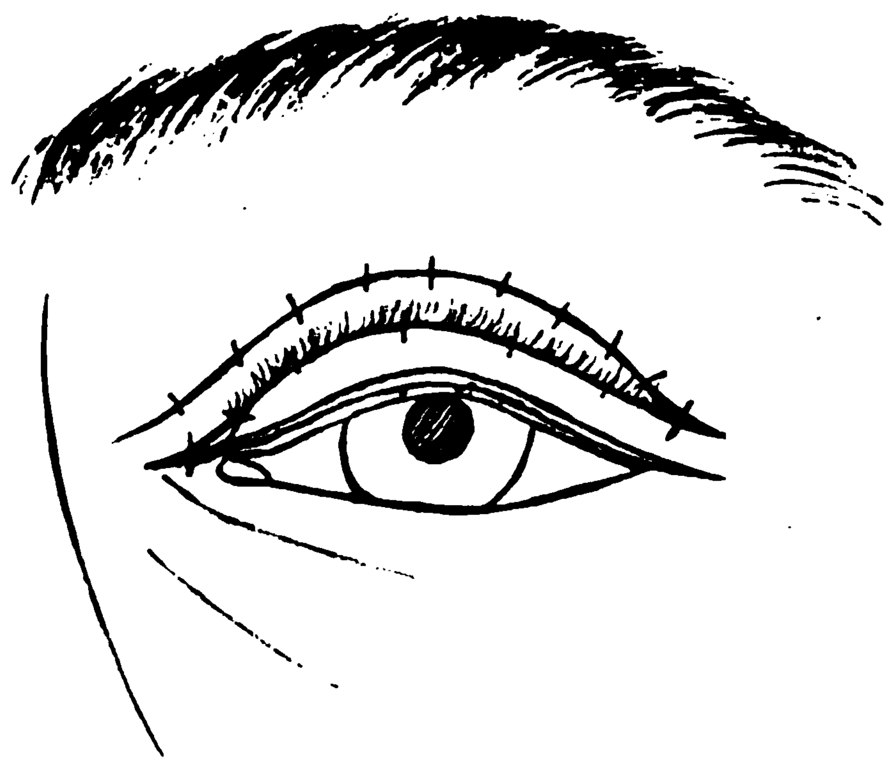


FIG. 130.—Spencer-Watson's entropion operation.

A further improvement was that made by Dianoux[2] who, in addition to the bridge containing the lashes, formed a second of integument, above and adjacent to the first. The two were then transposed and sutured. Both were fed by double pedicles, and as soon as practicable those of the intermarginal strip were cut (Figs. 133 and 134).

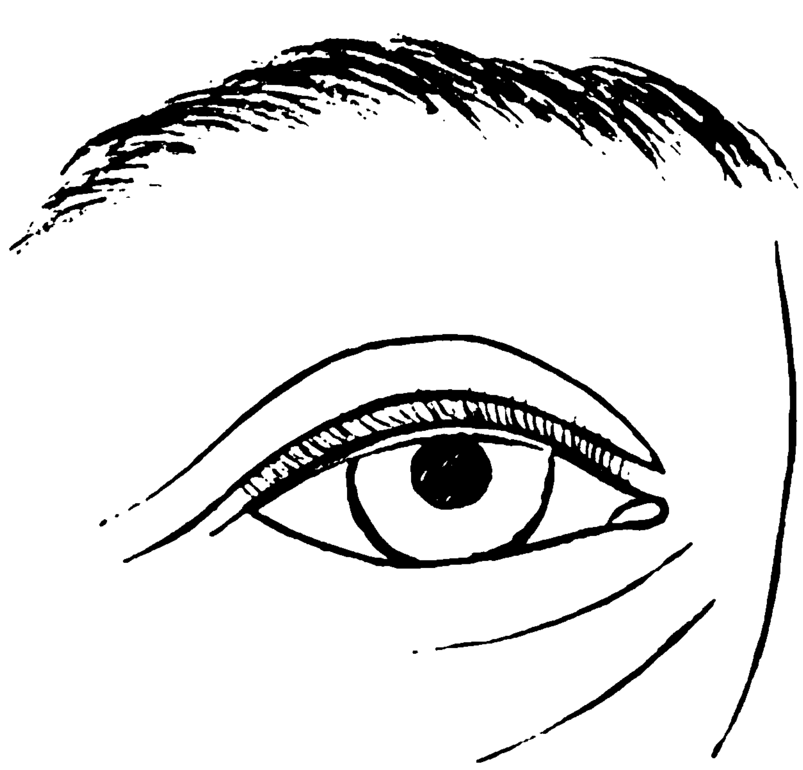


FIG. 131.—Gayet's entropion operation.

Waldhauer[3] made the Jäsche-Arlt operation, and rather than throw away the excised segment of skin, he covered with it the denuded lower portion of the tarsus—*graft without a pedicle*, after Le Fort-Wolfe.

Van Millingen,[4] of Constantinople, under the name of tarso-chiloplasty, still further improved the methods in question by substituting for the intermarginal skin graft one of mucous membrane taken from the inner lining of the lip. A broad strip of this tissue furnishes the requirements mentioned under both (*b*) and (*d*).

[1] Annal. d'oculist. t. lxxxii, 1879.
[2] Annal. d'oculist, No. 2, p. 132, 1882.
[3] Klin. Monatsbl., 1897, pp. 47–54.
[4] Oph. Review, p. 309, 1887.

The originator of tarsoplasty in this connection was Streatfield.[1] His operation consisted in the removal of a large horizontal wedge of tissue from the upper lid, which was composed of skin, orbicularis, and a small part of the center of the tarsus. No sutures were employed, the wound having been left to heal by granulation in order to increase the effect of the operation (Fig. 135). Thus was the third requisite (*c*) to the success of this branch of surgery provided.

FIG. 132.—Gayet's entropion operation. Lid averted.

It occurred to Snellen, of Utrecht, to combine this guttering of the tarsus with the Anagnostakis[2] method, the only difference being that double-armed sutures were used, starting in, through, coming back to the lower skin flap, and tying over glass beads. Chronis[3] added canthoplasty and, about the same time, Agnew subjoined external tenotomy or cantholysis to this procedure, and by these means the second requirement of (*e*) was obtained.

FIG. 133.—Dianoux's entropion operation.

Panas[4] made a similar operation to that of Snellen with two or three highly significant differences, viz., the careful dissecting up of the lower skin flap as far down as possible not to cut through and make a buttonhole, the passing the sutures through

[1] Royal London Hospital Reports, vol. i, p. 125, 1858.
[2] Van Gils Beiträge, Utrecht, 1870, p. 90.
[3] Rec. d'opht., 1875.
[4] Arch. d'opht., p. 208, 1882.

the line of cilia *beneath* the entire flap (not *through* it), and the fastening them by collodion to the brow (Figs. 136 and 137). This dissection and the drawing up of the lower flap, partly meet requirement (*f*). The point wherein it fails of the condition is the fact that the threads *push* the ciliary strip up instead of *pulling* it up and putting it on the stretch.

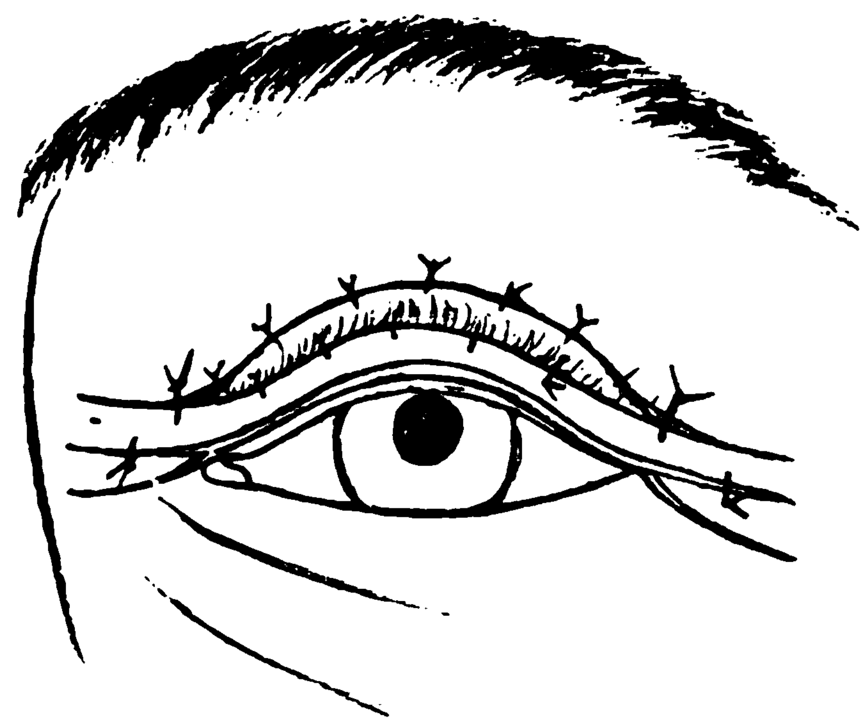


FIG. 134.—Dianoux's entropion operation.

A. Pagenstecher[1] made an incision just below the upper border of the tarsus, opened it up wide, exposed the tarso-orbital fascia, which was caught up in a horizontal fold, and through it were passed the sutures that traversed the two lips of the cutaneous incision. As a complete operation for entropion the proceeding fell far short, yet it served to obviate the droop of the upper lid and thus met requirement (*g*).

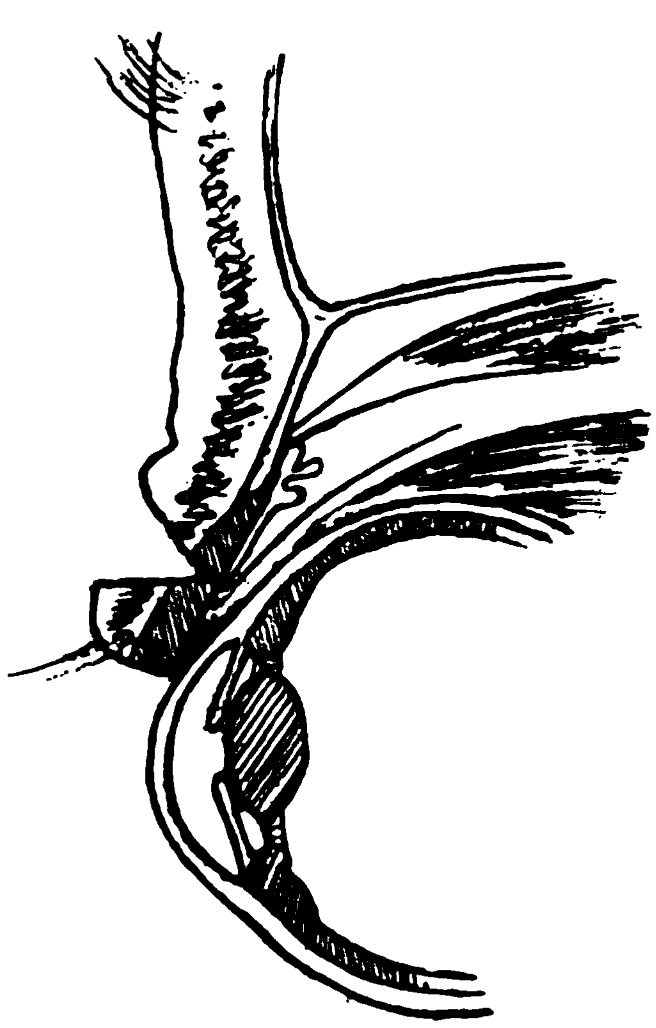


FIG. 135.—Streatfield's groove.

A résumé, then, of the fundamental principles of the modern operation for entropion of the upper lid, the measures devised in accordance with them and their authors would stand something like this:

(*a*) Fixed anchorage for sutures that hold up the flap containing the cilia: the tarsus and the tarso-orbital fascia. Anagnostakis.

(*b*) Support of same from below: transplantation of tissue. Spencer-Watson.

(*c*) Correction of incurvation of tarsus: counter-grooving. Streatfield.

(*d*) Replacing of tissue, to atone for shrinkage of conjunctiva, and to restore the angle of the free border: intermarginal grafts. Spencer-Watson, Gayet, and Van Millingen.

[1] Klin. Beob., 1861; and A. f. Oph., xxxvi, 4, S. 265.

(*e*) Relief of overtension of the lids and accompanying blepharophimosis. canthoplasty, cantholysis, and resection of the border fibres of orbicularis. Chronis, Agnew, Hotz.

(*f*) Redressal of the underhang of the skin at the free border, and the turning up (*not pulling up*) of the cilia: dissection of lower lip down to the cilia. Panas.

(*g*) Obviation of accompanying ptosis: tucking of levator tendon. Pagenstecher.

FIG. 136 Panas entropion operation.

FIG. 137 Panas entropion operation

The scope of any given operation for cicatricial entropion and trichiasis of the upper lid will be determined by how many of the six features here enumerated it will be fit for it to embrace. To put it another way, the extent of the surgical interference needed for the relief of a specified case will be governed by the number of abnormal conditions that are concerned in the production or maintenance of the entropion and the trichiasis. If, for instance, only partial absence of the angle of the free border is responsible for the trouble, the simple insertion of an intermarginal graft might furnish the remedy. If entire absence and nothing more, a Hotz operation would be added to this with, perhaps, canthoplasty. If

complicated with incurvation of the tarsus, counter-grooving must be joined with the other steps, and so on. As a matter of fact, the instances are exceedingly rare that are not all the better for giving one's patient the benefit of the whole category. For, if all the phases mentioned are not present in the particular case, owing to the never-ending progressiveness of the affection—on and on for years after all apparent traces of the primary disease have vanished—what the several parts of the operation do not accomplish in the way of actual *cure*, they will achieve as *preventives*. Another element that must be taken into consideration in defining the limits of an operation for entropion of the upper lid, especially when caused by trachoma, is the age of the subject. Those who come to us suffering from this disorder represent every period of life between ten and seventy years. I have known three generations of a single family to be under treatment at the same time. Naturally, in view of the perpetuity of the degenerative changes of the tarsus involved, one must strive for greater effect in cases of children and the younger adults whose lives are before them than in those of the middle-aged and the elderly, if it is hoped that the best results of one's work are to endure till the end.

How great, then, should be the effect? More than twenty years of service as surgeon to the Illinois Charitable Eye and Ear Infirmary, an institution whose outdoor and hospital clientele comprises some 12,000 new patients annually—of whom a large proportion were, a few years ago, admitted because of entropion from trachoma—have given the writer exceptional opportunities in this line of surgery, both as participant and observer. Unlike those whom we treat in private practice are these wards of the State. When their troubles recur they come back or are *sent* back to us, and it is almost a daily occurrence to see one return with an aggravated type of entropion, who a few years before, had been operated upon and "cured" of the same trouble in the same lids. It sometimes happens, too, that the recurrence is more pronounced than had been the first form. Certainly, the difficulties of the second attempt at restitution are in no way lightened by what was done at the first. On the other hand, it is much to be doubted if a well-made operation for cicatricial entropion has ever been followed by too great an effect. Many a one has resulted in lagophthalmos

from undue shortening of the lid, but not from too great an *eversion*. Presumably this last is possible, but it seems to be only theoretically so.

Wherein most operators fail is not that they do not obtain correction of the deformity, for the merest tyro among them succeeds in this, but *that their correction does not last*. In the pursuit of this branch of plastic surgery, therefore, it would not go amiss to take this as a maxim—*excessive immediate effect is necessary in order to insure permanent correction.*

Technic of the Operation.—The following description embodies the author's conception as to the surgical requirements of a pronounced cicatricial entropion of the upper lid, and also the details of his manner of procedure. The operation may be performed with or without narcosis. If dispensed with, cocain solution is dropped into the conjunctival sac. The infiltration anesthesia of Sleich is effective in preventing pain, but the swelling of the tissues it produces is highly prejudicial to nice results. The patient is prone upon a table. If both eyes are in need of the operation and the patient can or will submit to their occlusion for a few days, it is decidedly to his advantage, as to time, suffering, and inconvenience, to make the two operations in one sitting. One or two trained assistants are needed.

First step. **The canthotomy** (p. 217).—Free division of the external canthal ligament is indicated.

Second step. **Making of the intermarginal incision** that is to receive the graft. The lid is grasped, everted, and held back by the Beard lid forceps (Fig. 138) or by the tips of the fingers placed upon the eyelashes. Where the latter exists in sufficient numbers and length, one may dispense with the forceps. This instrument has proven most serviceable, as it effectually fixes the lid and prevents bleeding while the making of the cut is in progress. The scalpel, with extra convexity near the extremity of the blade, held as shown in Fig. 46, is employed. The incision extends from the outer limit of the free border to, but not including the punctum.

Where many fail is in making this cut too short and too shallow. If the entire free border is involved I do not hesitate to carry the incision past the punctum, i.e., to the inner canthus. An insignificant shallow incision will not retain the graft which, to be effective,

should sink in till its epithelium is lower than the surrounding lid margin. The position of the incision is in the posterior portion of the substance of the tarsus, rather hugging the boundary between tarsus and conjunctiva; it is about four millimeters in depth, and is made to gape widely that one may judge of its capacity. The lid is now turned back into place.

FIG. 138. Making the inter marginal incision for mucous graft.

Third step. **The Cutaneous Incision.** A broad lid spatula is pushed into the upper fornix and held by an aid (Fig. 139). With the same scalpel an incision is made through skin and muscle just below, and parallel with, the upper border of the tarsus, except near the extremities where it takes a horizontal direction, extending somewhat beyond the vertical line of the canthus in either direction. Its distance from the free border varies with the width of the tarsus.

Fourth step. **Dissection of the Flaps.** The lower lip of the incision, with its attached portion of the orbicularis, is lifted and

undermined, and the tarsus cleanly denuded down to the point where the cilia are seen to cross between it and the muscle, like

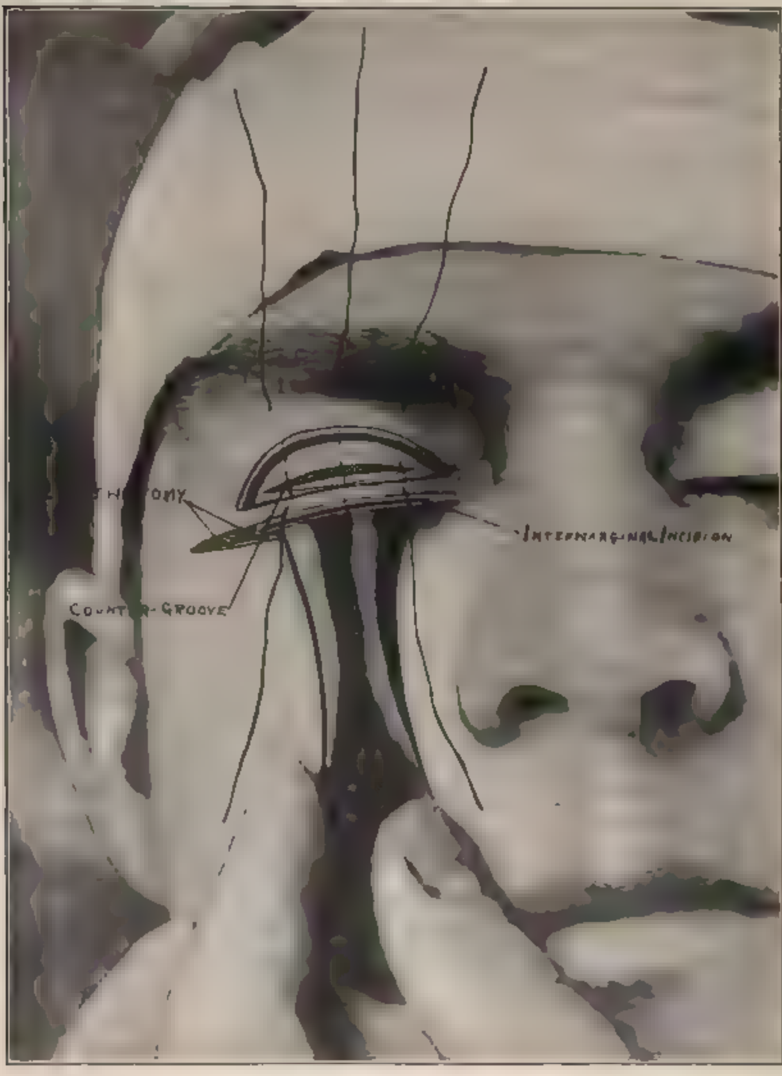


FIG. 149. "Altogether operation

black stitches in a seam. For this dissection it is best to use the *back* of the knife point, and the flap is thus loosened the entire

length of the free border. When the cilia are reached, in careful dissection, one feels the point of the knife vibrate as it chatters in passing over them. Buttonholing at this stage is to be avoided. The upper lip of the incision, with its underlying muscle, is loosened and pushed upward, so as to expose the tarso-orbital fascia (Fig. 141).

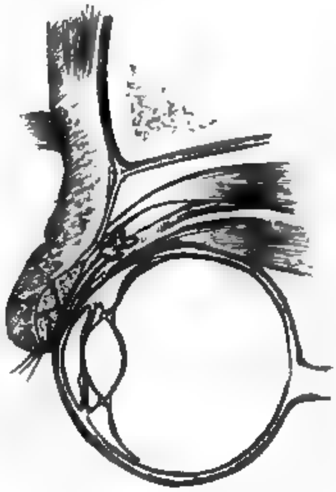


FIG. 140.—Beard's method for entropion. The heavy black lines show the incisions.

Fifth step. **Resection of the Border Fibres of the Orbicularis.**—The instruments are small, mouse-tooth forceps and delicate, blunt-pointed scissors. The upper edge of the muscle clinging to the lower flap is seized with the forceps and neatly excised from end to end in one long strip, the surgeon and the assistant meanwhile taking care of the skin edge to see that it is not nicked and notched.

Sixth step. **Counter-grooving of the Tarsus.**—The operator steadies the tarsus on the spatula, notes the line of greatest prominence of the horizontal ridge corresponding to the gutter on the inner surface, and with the same scalpel incises it. The two cuts needed for this purpose are so inclined that they meet at or near the posterior surface of the tarsus. If the conjunctiva should be slightly wounded in the act, it is of little consequence, though it were better to avoid it. The size of the wedge will depend upon that of the tarsus. The incisions will, of course, not go far beyond the ridge, which is often not so long as the tarsus. The thickness of the wedge is usually about two millimeters.

Wilder has devised an apparatus for excising the wedge of tarsus. It consists of a pair of small scalpels fixed in a holder. One movement suffices for the excision. The appliance is also used by its originator for cutting the cutaneous intermarginal graft for restoration of the lid border.

Seventh step. **Inserting the Sutures.**—One may use the ordinary

curved needles and holder or Reverdin's needle with handle. The needles should be small, fine, and sharp. Large ones cause needless traumatism. No. 2, braided, black, silk thread, boiled in paraffin, makes an excellent suture, of which three are put in, the first one midway of the tarsus and the other two, one on either side five or six millimeters away. Each needle is passed from below, through the lower flap just far enough from the edge to insure a firm hold for forty-eight hours, then through a small, horizontal fold of the tarso-orbital fascia, picked up in the forceps, just above the convex border of the tarsus, thence high up beneath the superior flap, and brought out through the muscle and skin but a short distance below the supercilia. To make the fold or tuck in the fascia, slightly dig the needle into it just where the crest should be, pull it up and grasp the base of the raised part with the mouse-tooth forceps, so as to form a horizontal pleat and pass the needle through, close to the jaws of the forceps (Fig. 141).

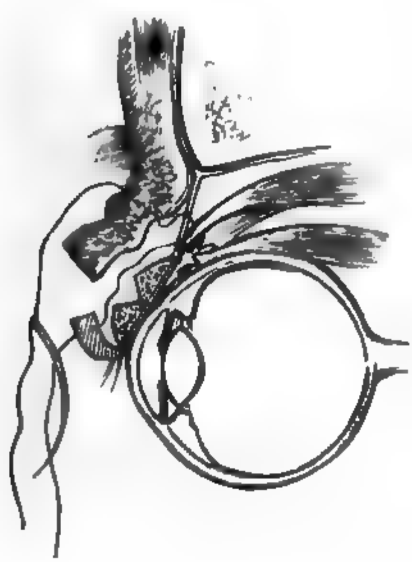


FIG. 141.—Beard's method for entropion. Shows course of sutures.

Eighth step. **Tying the Sutures.**—Here the closest attention to the detail of every maneuver is of the greatest moment. The lips of the intermarginal incision will now be found tightly glued together by fibrin. They are parted with the points of the closed scissors and all shreds cleaned out. So, too, as regards the flaps of the external opening. They are lifted up, and all blood, etc., removed from under them, so that they may slide over tarsus and fascia. The central suture is tied first. A double turn is made in the thread and the lower end given to the aid, while the operator holds the upper between thumb and index. The edge of the lower lip of the cut is grasped with the mouse tooth forceps near the thread to be tied, and drawn up, turned backward and placed in contact with the

fascia just where the thread enters the latter, or against the fold, simply pushing up the other flap with its edge also turned backward, just as described for the ptosis operation. While the flap is being thus held, the operator pushes down (or backward, as regards the eye) with the forceps on the weakened tarsus, to make sure that it bends with its concavity outward, closing the newly-made groove, and now surgeon and assistant pull together on the ends of thread and draw it tight, when the former takes both ends and completes the knot. Were the tarsus not pressed down in its middle this way, it might hump or buckle up, i.e., with its concavity downward and actually increase the deformity it was the aim to correct. The sutures, to complete the canthoplasty, are here put in and tied as per description under "Canthoplasty."

Ninth step. **Making and Placing the Graft.**—A wad of cotton wet with warm boric acid is laid over the lids. The patient's lower lip is turned out and gently washed with warm salt or boric solution not scrubbed and rubbed, so as to hurt the epithelium—and a small cotton sponge dipped in boric solution and tightly squeezed is pushed down into the pocket between lip and gums. A pair of large straight scissors, the same as are used for the canthotomy, answer best for cutting out the graft. The lip is caught between the thumb and index, rolled over the medius so as to evert well, the scissors opened very wide, the base of the blades placed firmly on that part of the mucous membrane that usually lies opposite the margins of the gums and, bearing down with the scissors while holding up with the middle finger from below, a long ellipse is excised with one snip of the shears that will fill the intermarginal incision. The piece will include not only the entire thickness of the mucous membrane, but a number of lobules of adipose tissue will be found attached to it. Turn it over, face down, upon the nail of the left thumb (or upon the rubber glove or gauze cot covering the same) and with the small scissors, carefully trim off all the adipose, paring it down to the submucous connective tissue.

A very thin, flabby graft is useless. It must have body as well as breadth. In respect to the latter dimension, as time goes on, I am inclined to make the grafts wider than of yore. In extreme cases, they would measure hardly less than seven or eight millimeters at the middle.

Rinse it in 1% salt or 4% boric acid solution at about 110° F., and place it flatwise in the cut back of the cilia, making sure that the epithelial surface is outward. The tips of tiny spindle-shaped cotton sponges are well wrung out of boric solution and applied about the edges of the graft, to drink up the slight oozing, the lid being all the time held everted as directed for making the marginal cut.

The graft must be ample in exactly the same proportion as is the intermarginal incision. If the first piece excised falls short of filling the cut, it is better to take a second, sufficiently large, to piece out, squaring and butting together their ends.

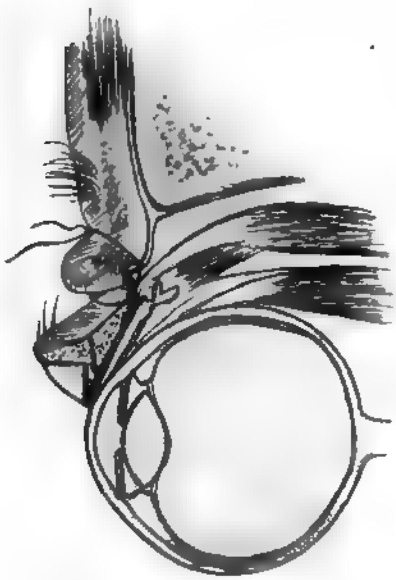


Fig. 142.—Shows completed operation.

No decided hemorrhage should be taking place from the wound when the graft is laid in, else a clot will form beneath and interfere with proper union. But a slight bleeding, which is always checked by laying in the graft, is an advantage in that it helps to fix and to hold the morsel in position. Sutures would be both useless and harmful, as when quickly put in (i.e., not fussed with too much) and stuck by fibrin, there is no possibility of the graft letting go, except, possibly, in removing the dressing (Fig. 142).

The latter consists, first, in the usual, thin layer of cotton wet with warm, boric acid solution, carefully applied to the closed lids (p. 15). There is a little point of considerable value that might be mentioned in this connection; after every other operation treated of in this volume, except the one now under discussion, the application of the first wet sheet of cotton is made by sliding it on to the lids from above, in order to smooth the lashes downward (see dressing after "Extraction"). In this instance the reverse obtains, viz., it is slid upward, for the reason that the primary effect of this

operation is to *turn* the cilia upward, like the feathers in a strutting peacock's tail, and such a manipulation of the dressing tends to heighten the result. To avoid loss of time in the first removal of the dressings, caused by prolonged soaking of the cotton, as well as to prevent loss of the graft itself, through having become glued firmly to the cotton, one may place next to the lids a piece of thin soft gutta-percha tissue. Upon this, a good-sized pad of dry cotton is built up and over all the wet netting roller is applied. The patient is kept quiet in bed for forty-eight hours, when the bandage is cut, the cotton removed by soaking with warm, boric acid solution and all the sutures are removed. The identical dressing is reapplied with renewal at twenty-four-hour intervals for a week or more. It will not do to leave off the bandage earlier, else the drying effect of exposure will cause the graft to perish and drop out. Even after the final removal of the bandage, it is well to keep the graft covered for a few days with a film of sterilized vaselin, for fear of desiccation. Formerly the wound in the mouth was closed by sutures, but of late nothing is done for it. It heals kindly by granulation and, moreover, most of the subjects are operated without narcosis, and are glad to be spared further "sewing."

Conclusions.—In my practice the several procedures just described, viz., canthoplasty, Hotz's method, counter-grooving of the tarsus, tucking of the tarso-orbital fascia, and the insertion of the post-ciliary mucous graft are nearly always combined in a single operation, which at the Eye and Ear Infirmary has come to be known as "the altogether." They are thus united not for convenience, but because experience has taught that by so doing the effect is greater, better, and more lasting. If the same were done piecemeal, i.e., for instance, first the canthoplasty, the Hotz operation a week later, and so on, the ultimate result would be much less satisfactory. Each of the multiple factors concerned in the entropion is attacked by an efficient foe and the defects are righted in a rational way by judiciously apportioning the effect among the several ills, rather than by giving too great prominence to one or two (Figs. 143 and 144).

With regard to the choice of mucous or of skin grafts for the restoration of the free border, ophthalmic surgeons are not in accord.

Knapp[1] prefers those of skin, claiming that it is the more suitable, inasmuch as the normal lining of the free border is dermal and not mucous. If one will take the pains, however, to examine a few lids that have been subjected to the operation, he will be readily convinced that the graft after a comparatively short time, really takes the place of conjunctiva in that it lies in contact with the cornea.

FIG. 143. The expression of face before "the altogether operation."

Others have urged as an objection to the mucous graft, that its shrinkage is greater than one of skin. Such does not agree with my observation. Indeed, an extended experience with grafts of the three, recognized varieties, viz., those of Wolfe, Thiersch, and Van Millingen, have led me to believe that the last are precisely those that retain more nearly their original bulk, and for the past ten or twelve years, I have resorted to "chiloplasty." The last bit of skin I made use of to replace the border was put into that of the lower lid where it lay in contact with the globe. Very soon an ugly ulcer appeared on the cornea immediately under the graft. Although not a hair could be found in the patch to cause the irritation, the ulcer persisted in spite of treatment. Finally it was remarked, in

[1] De Schweinitz, *Diseases of the Eye.*

everting the lid, that, while the surrounding conjunctiva was normally moist, the graft itself remained perfectly dry. This led to the conclusion that the oily nature of the epidermis was a hindrance to proper lubrication, hence the ulcer. The piece was excised, a graft from the lip substituted, and at once the ulcer healed.

The more thoroughly the various steps of the operation have been performed the uglier—from a purely cosmetic standpoint—

FIG. 144. The expression of face ten days after "the altogether operation."

are its early results. In a few cases so pronounced has been the ectropion, that a crust has formed on the palpebral conjunctiva from exposure to the air. This, with the large red grafts and the inverted lashes, all go to make a picture not overly attractive, yet, as before stated, I have never seen permanent hypercorrection. But a short while and all unsightliness disappears.

A serious and not infrequent sequel of operations for cicatricial entropion from trachoma is ulceration of the cornea. This occurs even in cases that had previously escaped this complication. Moreover, these ulcers are apt to be centrally located, just where they can do most harm to the vision, and heal least readily. One cannot, therefore, use too many precautions with the view to their

prevention; first, as to the choice of the case—never one in which the trachomatous process is still active; second, as to the preparation of the eye—make copious irrigation of the conjunctival sac with warm mild antiseptics immediately beforehand; third, as to the operation itself—not needlessly to injure the corneal epithelium by such things as too much cocain, broad spatula, or lid-clamps, nor by going through the entire thickness of the lid with the needles, thus pricking the cornea or leaving a loop of thread where it will rub that membrane. The effect of the free and prolonged instillation of cocain solution is unquestionably wrong in that it results in the drying and exfoliation of the corneal epithelium. A very few drops before beginning the operation is sufficient, and it should be seen to that the eye is flooded from time to time with warm boric solution. An additional safeguard would be the instillation of a few drops of a 25 to 50% solution of argyrol when about to apply the final dressing. This preparation is not only an effective antiseptic, but it is otherwise harmless, and, besides, has the property of remaining in the conjunctival sac for several days.

ORGANIC ENTROPION.

LOWER LID.

Cicatricial entropion of the lower lid does not lend itself so well to the surgical methods described in connection with that of the upper. Here the conditions are different. The transformation of the tarsus, the absence of the width of the free border, disappearance of its posterior angle, etc., do not figure so prominently as in the other case. Lid tension, the tension of the border fibres of the orbicularis, strain of the shrunken conjunctiva, and the blepharophimosis are the things chiefly to be contended against. These, together with the anatomical peculiarity of the inferior tarsal plate—that is, in being only about one-half the width of the superior one—necessitate a mode of handling quite special. It is true, however, that absence of the free border occasionally constitutes the main fault, and the placing of an intermarginal graft the best remedy.

The prime **indications** are to release the lid from the binding pressure of the contractile and shrinking tissues, by resection of the border fibres of the orbicularis, by canthoplasty with cutting

of the external canthal ligament, and by piecing out the conjunctiva with grafts of skin or mucous membrane. These measures may, in occasional instances, be supplemented by the judicious employment of operations for the shortening of the adjacent integument.

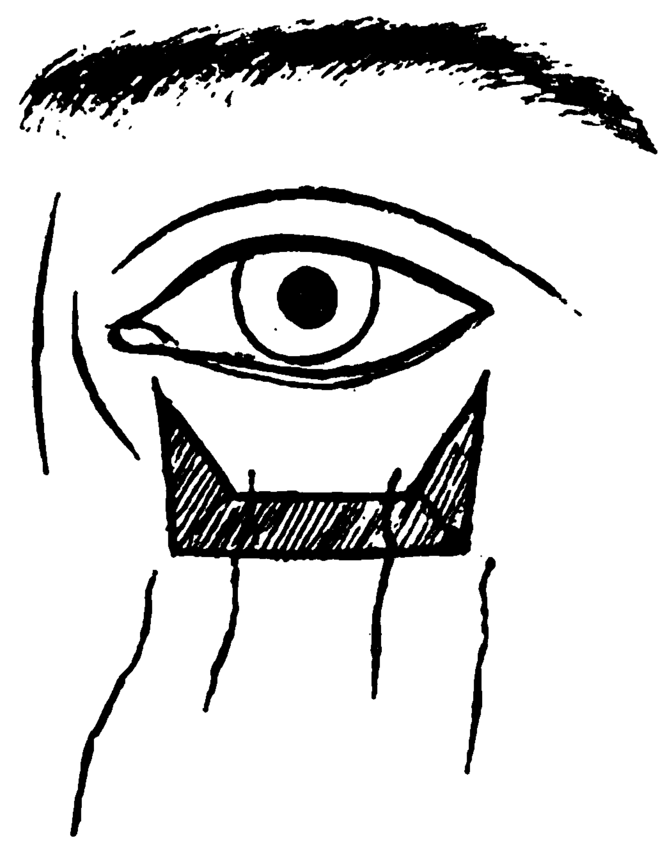


FIG 145.—Panas' operation for entropion.

Among the best of these is that of Panas[1] (Fig. 145). The resulting cicatrix corresponds to the natural topography of the region. It is executed as follows: two vertical incisions, each about one centimeter long, are made through skin and muscle, one near the outer canthus, the other near the inner, their upper extremities close under the cilia. Their lower ends are joined by a horizontal incision through skin only. The flap thus outlined is dissected up to the very roots of the eyelashes, everted and a strip of the premarginal fibres of the orbicularis is excised. A parallelogram is trimmed from the lower edge of the loosened flap, its width proportional to the amount of shortening demanded, and the opening closed by fine sutures.

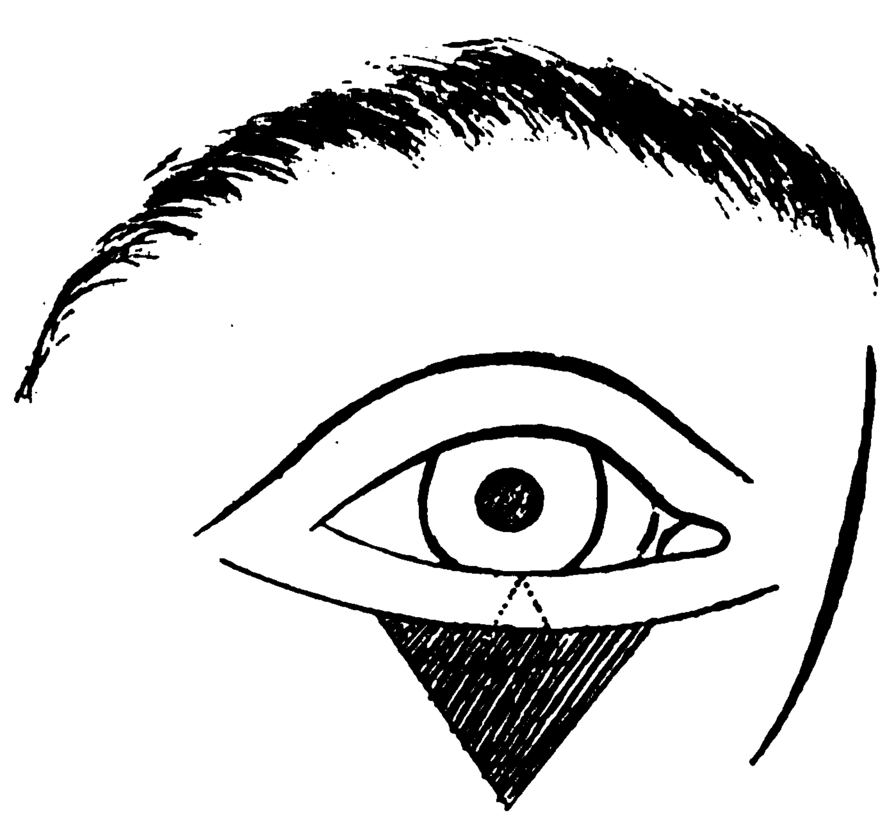


FIG. 146.—Graefe's operation for entropion.

V. Graefe gave a method that has often done good service (Fig. 146). Three millimeters from and parallel with the free border, an incision is made through skin and muscle, extending nearly the entire length of the lid. A triangle of skin, whose base rests on the middle of the first incision, and whose size is governed by the degree of effect aimed at, is excised—muscle not included. The strip

[1] Mém., Thèse de Paris, 1873.

of skin and muscle lying next to the margin are caught with forceps and dissected from the tarsus until the cilia are exposed, taking care not to buttonhole, and the attached fibres of muscle removed with scissors. The two corners of skin are undermined and the whole opening closed by small sutures. If still greater effect is wanted, a triangular piece of the tarsus may be excised, base downward, or in the opposite direction to that of the skin triangle (see dotted lines in accompaning cut).

The curious operation for entropion of the lower lid that bears the name Flarer-Stellwag[1] was made by "scalping" the lid, turning the abscinded strip upside down and replanting it.

ECTROPION AND BLEPHAROPLASTY.

The name ectropion which is the exact opposite of entropion, refers to an eversion or turning outward of the lid, either partial or total. The degree of eversion varies between that slightest of all partial forms, wherein the lower punctum loses its suction on the globe by the merest separation therefrom, to that most extreme of total ectropion, where, through extensive destruction of the integument surrounding the palpebral fissure and the subsequent contraction, both tarsi are not only inverted, but drawn widely asunder so as to expose the entire area of the conjunctival sac.

For convenience, we may separate the varieties of ectropion into four grand divisions, which, given in the inverse of their importance or frequency are, (*a*) Spastic, (*b*) Mechanical, (*c*) Atonic, and (*d*) Cicatricial.

Spastic ectropion, muscular ectropion, acute ectropion, are several names that denote the same condition, and affect mainly the lower lid. Spastic ectropion has its beginning in some sudden swelling of the conjunctiva or advancement of the globe that tends to push forward the free or straight border of the tarsus. At the same time the backward pull of the orbicularis, through normal contraction upon the convex border, together with the continuance of the outward push of the border, completes the eversion by overcoming the action of the marginal fibres. The ectropion once ac-

[1] Flarer:Reflexioni sulla trichiasi, etc. Milano, 1828. Stellwag, v.c.: Ein neues Verfahren gegen einwärtsgekehrte Wimpern. Allgem. Wr. med. Ztg., 1883, Nr. 49.

complished, the latter fibres only serve to maintain it. This condition, when exaggerated, may be termed blepharo-paraphimosis.

Mechanical ectropion is really a less acute form of the above, in which both lids may be involved, and, in cases of long standing, is characterized by structural changes in all the tissues of the lids, but more particularly the innermost. The active force is referable to exophthalmos, ectasia of the globe from staphyloma, tumors, etc., or to growths and chronic swellings, hypertrophy, etc., of the conjunctiva (*mucous ectropion*). The perverted action of the orbicularis, alluded to, figures here also.

Atonic ectropion chiefly concerns the lower lid, and may be due to (*a*) paralysis or paresis of the orbicularis—*paralytic ectropion*—or (*b*) relaxation of all the tissues of the lid, with lengthening of the free border—*senile entropion*. As a complication of this form, hypertrophic conjunctivitis of the lower lid and epiphora occur, and can easily be mistaken for a purely mucous ectropion.

Cicatricial Ectropion.—In this variety, the eversion is the indirect result of a burn, other injury, or disease that destroys all or a part of the skin of the lids. The destruction that causes ectropion rarely extends deeper than the superficial fascia, or, at most, the orbicularis. When the deeper leaf, viz., the tarsus and conjunctiva, is carried away, that is another affair. The principal agents in bringing about the condition are the contraction of the scar and, after the eversion is pretty well established, the anchylosis in the external sulcus. The location and extent of the scar will determine those of the ectropion.

As to the **surgical means** adopted for the correction of ectropion, they will depend mainly upon the nature of the defect. For the purely *spastic* kinds, it will ordinarily suffice to remove that which is most active in producing it. Treatment of the conjunctivitis, or whatever the cause, putting on strips of adhesive plaster to keep the palpebral fissure closed, and bandaging, if the conditions will admit of this. If, however, there is strangulation from the muscle-cramp, an immediate canthotomy (p. 217) with free cutting of the external canthal ligament is needed. For the mechanical form, as in the spastic, attention to the ulterior cause is often the sole means, be it the ablation of anterior staphyloma, the removal of a tumor of the globe, tarsus or conjunctiva, or the relief

of a transient exophthalmos. Should it be from a more lasting but benign and reducible exophthalmos, median tarsorrhaphy would likely be the most eligible recourse (p. 222). Mucous ectropion of the lower lid will, in most instances, yield to local medical treatment, together with adhesive or collodionized strips to support the lid, and bandaging. Failing in this, one would far better try one of the simpler surgical procedures, such as the insertion of a Snellen[1] suture, rather than the employment of more radical measures, or resort to such irrational and primitive methods as cauterization or excision of the offending conjunctiva.

FIG. 147 —Snellen's suture for ectropion.

An excellent means of holding up a sagging lower lid for an extended period, as well as for the better closure of the palpebral fissure in certain cases of lagophthalmos, is by the use of the contrivance invented by the writer for the coaptation of shin-wounds in general surgery.[2] This consists of a strip of tarlatan ribbon, near one selvage of which is attached a row of tiny flattened hooks, similar in shape to those employed in connection with "eyes." A strip of this is fastened, by flexible collodion, hooks up, to the lower lid; and another, hooks down, to the brow. The two are then laced, with a suitable cord, the lids approximated as nearly as desired, and the cord tied in a bowknot.

The Snellen Suture.—A No. 2 braided thread of silk, boiled in paraffin and armed with two curved needles, is gotten ready. The eye is cocainized. The needles are passed down into the most

[1] Van Gils Beiträge, p. 90, Utrecht, 1870

[2] Described in a paper read before the Chicago Medical Society, and published in the Medical Recorder for June, 1903.

prominent fold of the exposed conjunctiva, obliquely through the tarso-orbital fascia, at its junction with the tarsus, on down and forward to emerge from the skin opposite the rim of the orbit (Fig. 147). They enter about one-half centimeter apart, and their courses very slightly diverge. Two or, at most, three such sutures are placed and each pair is tied over a cylinder of gauze or tubing. The tension put upon them is just sufficient to cause a slight entropion. They are left in for several weeks or until suppuration appears around them, the eye being meanwhile bandaged, with daily renewal and cleansing. Silver thread is preferred to that of silk by a number of surgeons, the assumption being that the metal is better tolerated. I think, however, that if the silk is thoroughly boiled in paraffin, so that it will not act like an open path for the entrance of bacteria, that it will be found superior to any other material.

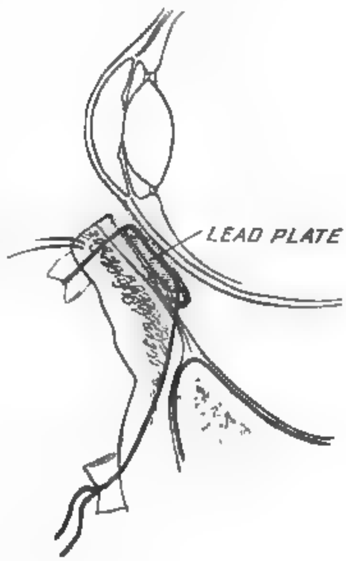


FIG. 148.—Argyll-Robertson suture for ectropion.

Argyll-Robertson[1] devised a knot which he used in conjunction with a lead plate. The needles of a double-armed suture were passed from in front, through the whole thickness of the lid, each one about six or seven millimeters from the middle line, and two millimeters from the border. Then carried free over the conjunctiva and, entering at the bottom of the cul-de-sac, were brought out on the cheek some thirty-two millimeters below the lid margin. Before tying the ends over tubing a lead plate (25 x 6 x 1 millimeters), with ends and corners smoothly rounded, was slid beneath the threads lying on the conjunctiva. The object of the plate was to straighten the out-curve of the tarsus and the infold of the fascia resulting from the ectropion (Fig. 148).

Fukala[2] is the author of a combined suture and incision operation

[1] Edinburgh Clinical and Pathological Journal, 1883.
[2] Berliner klin. Woch., 1891, S. 287.

that has met with approbation. Jaeger's lid spatula is put into the lower fornix and an incision made through skin and muscle, down to the tarso-orbital fascia, ten to twelve millimeters from the free border, parallel with it, and somewhat longer than the palpebral fissure. The upper flap, with its muscle, is undermined up to the cilia and the fascia is exposed. Three sutures are introduced as follows: the needle is passed through loosened skin and muscle four millimeters or more from the border, thence carried upward, between muscle and tarsus, and passed straight through to the conjunctival surface, close up to the cilia. It is taken back the same route, only three millimeters away. One thread is placed in the center and one near either canthus and tied over sections of tubing. In closing the incision with interrupted sutures they are made to dip in and out of the tarso-orbital fascia, much after the manner of those used in Hotz's operation for entropion. The chief feature is the doubling of the skin flap upon itself (Fig. 149). Angelucci[1] makes a similar operation in all save that no sutures are used. Atonic ectropion, whether the result of actual paralysis of the orbicularis or from a senile atrophy and relaxation of the tissues of the lid, requires practically the same surgical treatment, though the age of the subject, and the prospect of a cure, as in the case of certain paralyses of the seventh nerve, would have a tendency to qualify the means.

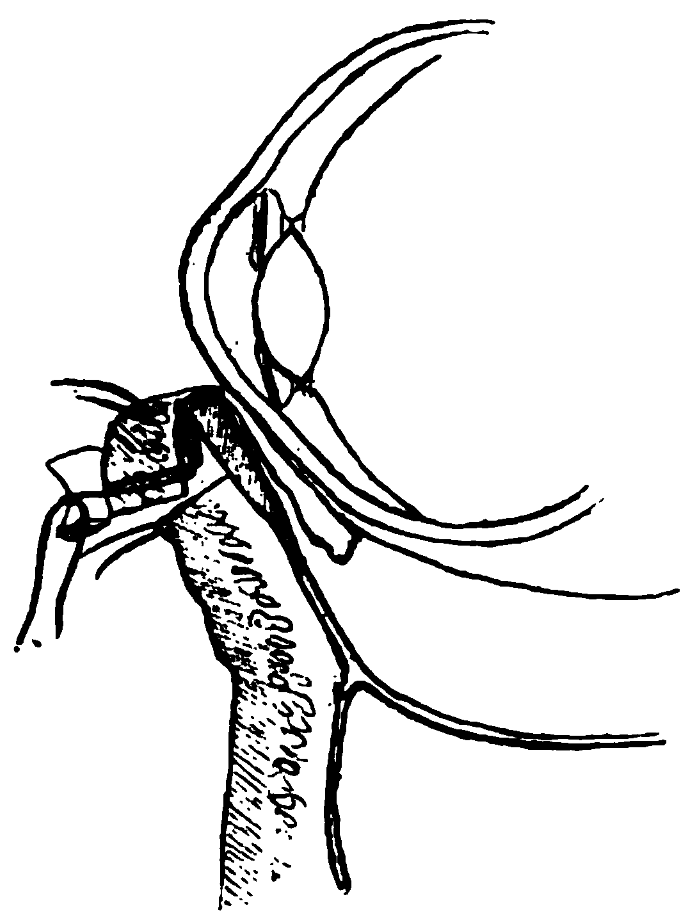


FIG. 149.—Fukala's incision and suture for ectropion of the lower lid.

Three **dominant principles** underlying most of the operations that have been undertaken for this variety of ectropion, are: (1) shortening the free border by excision of a wedge therefrom, (2) the pushing up and shortening by means of sliding flaps and excision of a triangle of skin at the external canthus, and (3) the narrowing of the palpebral fissure, or the holding up the drooping lid, by one of the forms of tarsorrhaphy, or combinations of these. The fact

[1] Rev. gén. d'Opht., 1898, No. 9.

that the lid in this variety of ectropion does not so much incline to inversion of the tarsus as to a festooning or sagging downward of the free border, constitutes one of its most distinctive features. In other words, in cases of long-standing senile ectropion, the lower lid becomes so elongated that it is impossible for it to coapt nicely with the globe, even if the original cause of the ectropion were no longer active. This peculiarity was noticed by physicians in the early days of modern medicine and the first operations conceived for righting the defect were directed to this fullness.

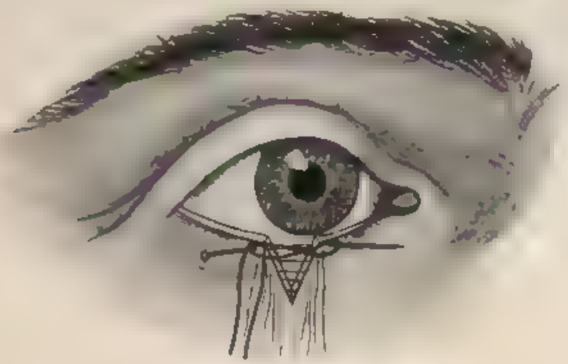


FIG. 150. Adam's operation for ectropion

Such was that of Sir William Adams[1] which is the forerunner of all those that include excision of the tarsus. This surgeon was bold enough to excise a gore from the very center of the lid (its size regulated by the amount of surplus in the lid) that included the whole thickness. To hold the edges of the notch in apposition, he put in, as near as practicable to the border, a surgical pin, on to which was wound a figure-of-8 ligature. For the rest, fine interrupted sutures (Fig. 150).

Von Ammon,[2] not satisfied with the cleft often, and the conspicuous scar always, left in the middle of the lid, took the gore from the outer canthus (Von Ammon-Adams operation) (Fig. 151), then proceeded as did Adams; yet not, as has been stated in some text-books, as did Walther,[3] who included the outer extremities of both

[1] Practical Obs. on Ectrop., 1812, p. 4.
[2] Zeits. f. Aug., i, S. 529.
[3] Syst. der Chir., vi, 1828.

lids for the correction of double, i.e., upper and lower, ectropion (Fig. 152). It has been urged against these operations, when made at the outer canthus, that the site is situated too far from the point most desirable to effect, viz., the vicinity of the punctum. Certainly, those made in the center have as many faults.

Fig. 151.—Von Amon's modification of Adam's operation for ectropion.

Of later years, Kuhnt[1] has given still another modification of the original Adams operation. The accompanying illustrations, taken from Terrien's excellent work on eye surgery, will describe the method better than words (Figs. 153 and 154). It will be seen that the skin is not included with the triangle cut from the tarsus and conjunctiva. While there is no doubt of the ability of the operation, in many instances, to relieve the ectropion, there is the risk of the cutting through of the marginal sutures, and the leaving of a permanent nick. Then, too, the decided folding of the skin at the border is objectionable.

L. Müller[2] sought to remedy these shortcomings—and not without a degree of success by altering Kuhnt's method, as per the illustrations (Figs. 155 and 156), also taken from Terrien. The sutures that close the widest part of the tarsal V are held on one side by skin, and the slack of the latter, instead of being taken up in one pleat, is divided among several.

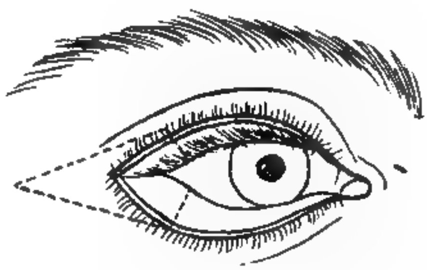


Fig. 152.—Walther.

Heembold,[3] in order to obviate the tuck of skin made at the center of the lid in the Kuhnt operation, removes a triangle of skin corresponding to that of the

[1] Beiträge z. operativ Augenh, 1883, Jena.
[2] Kl. Mbl. f Aug., Bd. xxxi, 1893, S. 113.
[3] Klin. Mbl. 1897, p. 283.

tarsus, but further out, splitting the lid between them. The two clefts thus made are sutured separately. These procedures are equally applicable to certain cases of cicatricial ectropion as, for example, from a small scar that may be included in the excised portion.

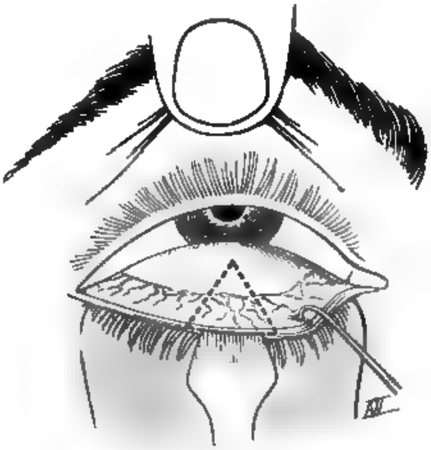


FIG. 153.—Kuhnt, No. 1.

A quite satisfactory way, hit upon by the writer, of dealing with the defect in question, is to make canthotomy and extend slightly the skin cut, then loosen around, below, remove a small triangle of skin containing a few cilia, force out—skin as it were—the outer extremity of the lower tarsus, grasp it with fixation forceps, and while skin and conjunctiva are retracted, pass a No. 2 silkworm, or catgut, suture through, from without, at a distance from the cut end proportioned to the length of the proposed shortening, after which the superfluous bit of the tarsus is abscised. Now, a small triangle of integument and muscle (base in) is cut from the upper lip of the canthotomy, exposing the external canthal ligament. Through the latter is passed, from within, the suture just put into the tarsus, the ends are knotted and cut off short, while the skin opening is united by fine black silk sutures, and the conjunctival incision is left to itself. The buried suture is afterward absorbed or encapsuled (Fig. 157).

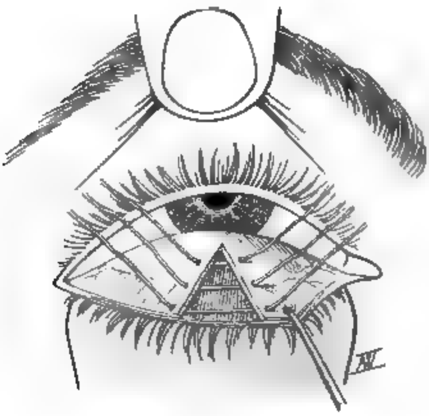


FIG. 154.—Kuhnt, No. 2.

The second category of operations for atonic ectropion have for

their object the pushing, or pulling, the lid into place by the excision of a triangle of skin and muscle near the outer canthus, the mobilizing the surrounding edges, and the closure of the gap.

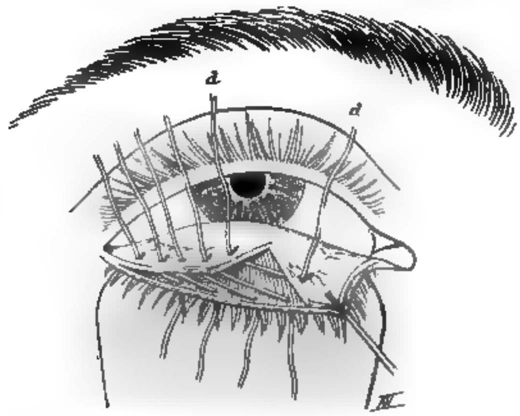


Fig. 155.—Muller, No. 1.

The first of these was that of Dieffenbach.[1] This consisted in making a horizontal, cutaneous incision, beginning at the outer commissure, whose length was governed by the amount of lid slack

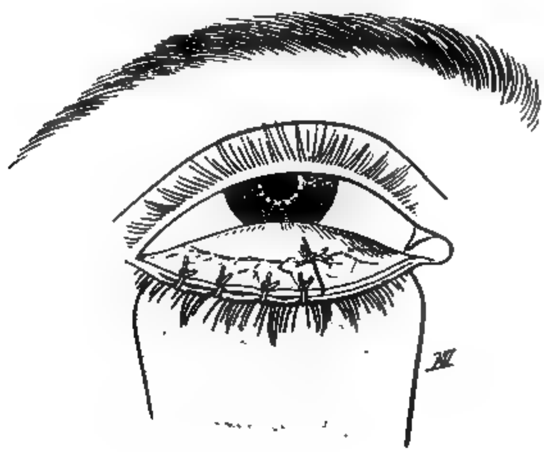


Fig. 156.—Muller, No 2.

to be taken up. From the extremities of this incision two others were made, in a downward direction, so converging as to unite in forming

[1] Zeis Handbook f. pl. Chir., 1838.

an equilateral triangle. The skin and muscle thus enclosed were extirpated. The outer edge of the lower lid was pared off for a distance coinciding with the length of one side of the triangle. The skin at the inner side of the angle and beneath the outer half of the lid was undermined, the whole lower lid slid outward, closing the angular opening, and the coapting edges were sutured. Thus the pared, or raw, part of the lid margin becomes the lower lip of the primary, or horizontal, incision (Figs. 158, 159).

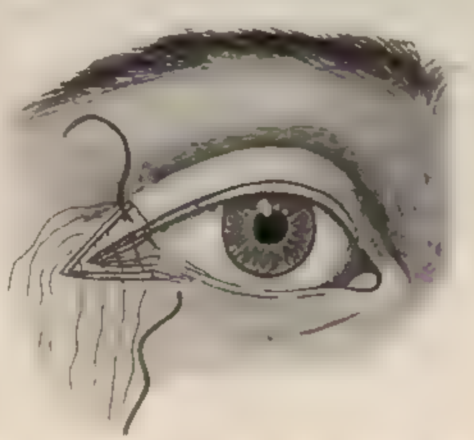


FIG. 157. Beard's operation for elongated lower lid.

Method of Szymanowski.[1]—With a view to the elimination of the downward traction of the scar on the outer commissure and also to the enhancement of the effect, this surgeon has changed the form and axis of the Dieffenbach triangle (Fig. 160). That is, he places its apex at the commissure, extends one short side up and out, gives it a long, vertical base; then a third side, of intermediate length, leading back to the canthus. In other respects the method does not differ from Dieffenbach's. Thus, the upward slant of the short side gives the procedure added capacity for lifting up the lid, and the long, narrow cicatrix, extending as it does both up and down from the level of the commissure, does not tend to the latter's displacement. The effect, moreover, is easier to *dose* than is that of the older operation.

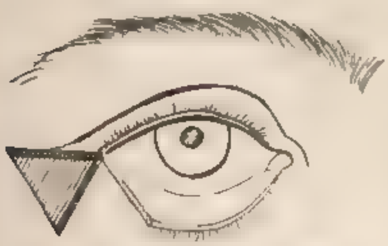


FIG. 158. Dieffenbach, No. 1

The outer portion of the lid border AD is prepared by removing its edge to a depth sufficient to include the hair follicles, and for a

[1] Graefe-Saemisch Handb., Bd. iii, S. 466

distance commensurate with the surplus length of the margin. The incision AB, made about at right angles to the tangent of the curve of the upper border, should be somewhat longer than AD. BC is nearly three times and CA twice as long as AB. In undermining, to mobilize the skin and muscle, only the side AC is loosened, and to the extent indicated by the dotted line, leaving the other two fixed for supports. In closing, the opening D is sutured to B. A strong point in this sort of operation is that the elongation of the tarsus is definitely disposed of.

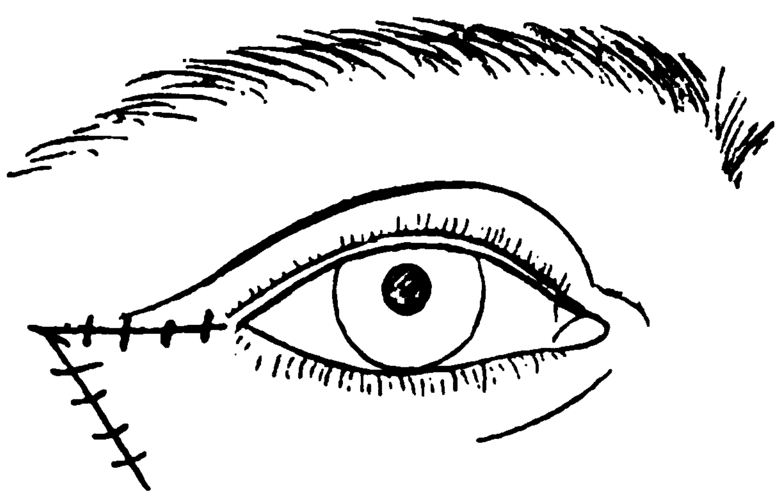


FIG. 159.—Dieffenbach, No. 2.

The third class of operations for this kind of ectropion is composed of the several operations for tarsorrhaphy—or blepharorrhaphy—already described (pp. 220–224) for occlusion of some portion of the palpebral fissure. It may be the external tarsorrhaphy of Fuchs, the internal (German *median*) of v. Arlt, or the median of Panas. In the writer's opinion, only the latter has a place in modern ocular surgery, and even it is seldom indicated. He would rather trust to one of the other procedures mentioned in connection with this subject or, in extreme cases, to a combination of more than one of them. For example, a resection at the outer commissure in conjunction with a Snellen suture, where the ectropion is a mixture of the atonic and the mucous types or, if the operation made at the canthus failed to reinstate the punctum, one could resort later to such a procedure as that of Wharton-Jones (Figs. 164–5)—placing the apex of the V directly beneath the punctum, so that the maximum of pushing upward of the lid would be where it would do the most good. In the event of an incurable

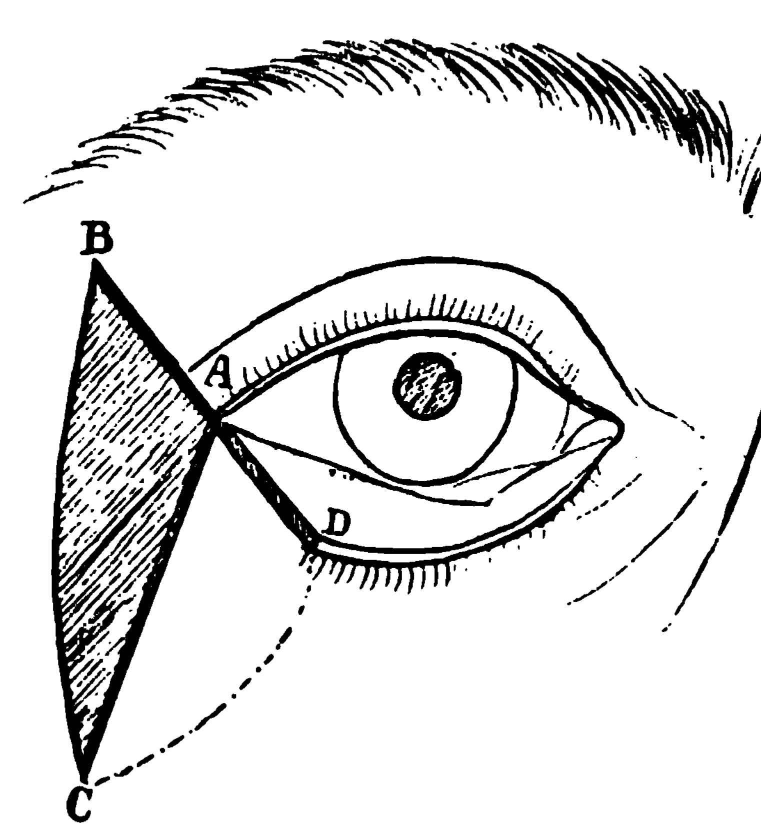


FIG. 160.

paralysis of the orbicularis, with ectropion, the most satisfactory single operation, taken all in all, is probably the median tarsorrhaphy. It will more surely relieve the troubles from epiphora and from exposure of the globe and prove more lasting as to its benefits.

Operations for Cicatricial Ectropion and Other Blepharoplasty.—It is customary to make two subjects of the above terms and to treat them separately. Technically, one means a turning out of the lid from a cicatrix and the other, plastic surgery, for the restoration of the lid Seeing that some part is destroyed in almost all cases of the ectropion under discussion and must be restored, it is a pretty difficult matter to disunite the two, even in theory, and as to actual practice, they are one. In all that has been written on "blepharoplasty" a vast majority of the cases cited have been those of cicatricial ectropion. An operation for the restoration of any part of the nose is *rhinoplasty;* for any part of the lip, *chiloplasty*—why go on trying to perpetuate "a distinction without a difference?"

This is the most common, as well as the most serious form of ectropion and the most difficult to handle. A glance at the more frequent causes of partial or complete destruction of the eyelids and the kinds of cicatrices they leave may not be amiss. First in the list stand burns from fire or chemicals. These are apt to be deeper, in the first instance, seeing that the victim often receives the injury as a helpless babe, or invalid (epileptic), and the contact is prolonged; while, in the second (those from strong caustics and acids) they usually affect the skin only. Next in point of frequency is epithelioma, or rodent ulcer, which, when situated in the region of the tarsus, usually destroys the whole thickness of the lid within the ulcerated area. The scars from syphilis and lupus, like those from fire, although the disease is primarily from the skin, are liable to penetrate beyond it. Another cause of cicatricial ectropion that has come well to the front, particularly in the vicinity of Chicago, is blastomycosis or blastomycetic dermatitis. The resulting scar rarely reaches below the superficial fascia.

The gravest cases will sometimes tax the resources and perseverence of the surgeon to the utmost and, unfortunately, exhaust those of the patient completely. As before hinted, the nature of the primary injury and its extent, considered together with its date, will govern in the choice and compass of the surgical measure

selected for the relief of the ectropion. Now and then one meets with an eversion of the lid from a scar so slight that the mere subcutaneous division of a restraining band or the excision of the entire cicatricial mass, followed by the mobilization and righting of the tarsus and closure of the opening, with perhaps consequent massage and stretching of the affected skin, will lead to perfect cure. As a rule, however, *the indispensable element in the surgical management of cicatricial ectropion as well as in blepharoplasty, in general, is the replacing of lost substance,* which refers mainly to the skin.

There are four ways of obtaining the borrowed integument and of bringing it to its new situation to fill the defect:

1. By fashioning and mobilizing flaps of the adjoining skin and putting them in place by simple sliding or interchanging. *Autoplasty by the French method.*

2. By cutting pedunculated flaps from the nearby skin, not necessarily adjacent to the defect, and moving them into position by turning or twisting of their pedicles. *Autoplasty by the Indian method.*

3. By entirely detaching pieces of skin of various dimensions from a distant locality and transplanting them in or about the lid *Autoplasty (or heteroplasty) by cutaneous grafts.*

4. By transporting a pedunculated flap, formed from a remote part of the patient's body or from the body of another individual. *Autoplasty (or heteroplasty) by the Italian method.*

The first two refer, of necessity, to autoplasty pure and simple, and to that only. That is, the integument is taken from the same individual, and from the immediate vicinity, or from one but slightly removed. The third mode, while usually autoplastic, is occasionally *heteroplastic*, in that the material is taken from another person, or it has, in rare instances, been *zooplastic*—got from skin belonging to one of the lower animals. The fourth, although not of necessity autoplastic, has, as far as it concerns blepharoplasty, never been anything else.

It were vain to attempt an enumeration of the various operative schemes of more or less merit that have been devised for cicatricial ectropion, much less to think of describing them. Let it suffice, therefore, to detail a few representative procedures, under the

several headings, and to present certain other examples by means of pictures that will speak for themselves.

1. The first (French) mode is best adapted to cases in which the loss of lid tissue and that of the surrounding skin has been relatively small. This is not to say that the method is applicable only to partial or circumscribed ectropion. On the contrary, the latter may be complete, and affect either one or both lids. And part of the available integument may be cicatricial, yet it must be not deeply scared over any considerable area, and must be capable of being loosened from beneath, and made into sliding flaps, excepting for such limited portions as will admit of being excised without being detrimental to the general result. Tarsorrhaphy, provisional or definitive, was a necessary adjunct to most of these operations, but it may often be omitted, and the ultimate effect heightened by overlapping the lids, and fixing the operated one by collodion or other means.

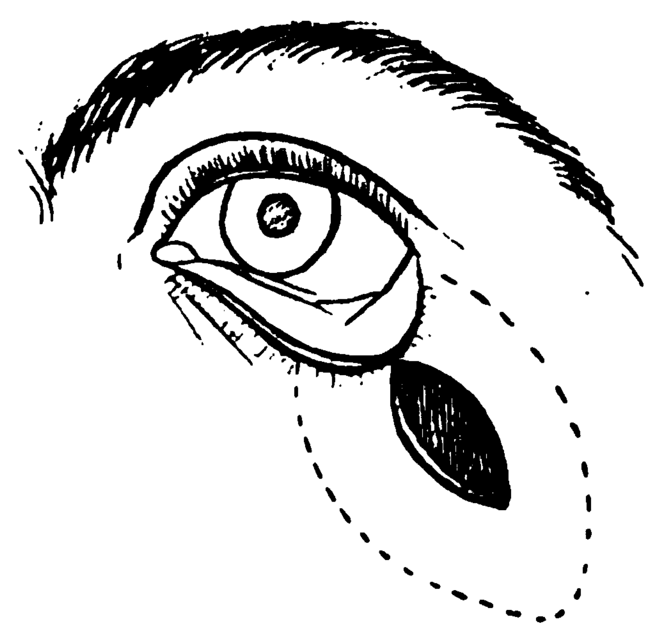


FIG 161.—Von Ammon.

Given an ectropion from a deep circumscribed cicatrix with its long axis vertical, and that cannot be readily excised, as when continuous with bone, one may have recourse to the process of Van Ammon (Fig. 161). This consists in surrounding the cicatrix by an elliptical incision, removing its top to a depth corresponding with that of the contiguous skin, and leaving the rest to be buried. Free dissection is made all about the opening, the lid is righted, pushed up high onto the globe, and the wound closed by interrupted sutures.

For ectropion of the lower lid, from a deep scar of moderate size, if not too near a commissure, the old operation of Dieffenbach is still practised. The adherent portion is encompassed by three straight incisions that form a triangle with its base near and parallel with the free border. The area thus enclosed is excised. From either extremity of the incision forming the base of the triangle, start a short incision, each about one-half the length of said base, both lightly curving, the one down and out, the other down and in. The upper lip of the whole incision is undermined up to the lid

border, and the lid turned back into position. The lateral flaps are dissected up and brought together, the resulting lines of union presenting the shape of a capital T. External tarsorrhaphy completes the operation (Figs. 162 and 163). It is rather curious to note that von Graefe, according to Baudry,[1] applied the same operation, minus the tarsorrhaphy, to *entropion* of the lower lid.

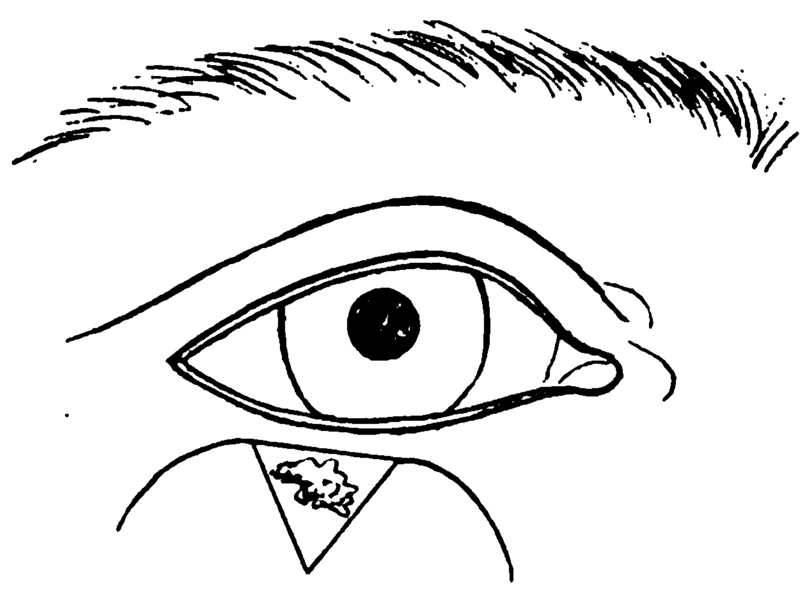


FIG. 162.—Dieffenbach.

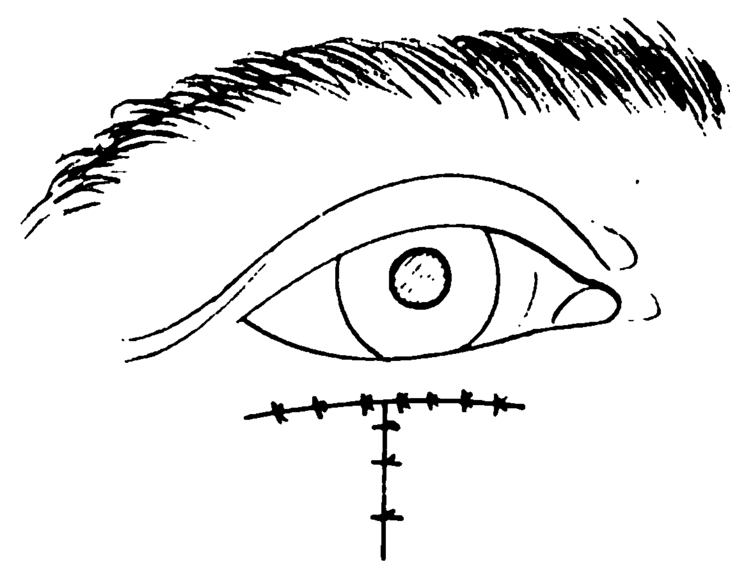


FIG. 163.—Dieffenbach.

A classic operation for cicatricial ectropion of either upper or lower lid, is that of Wharton-Jones, slightly modified by Sanson (Figs. 164 and 165). Two converging incisions, beginning near the free border, are made to include the scar and meet beyond it, like the letter V, upright for the lower lid, inverted for the upper. The triangular flap is loosened from its apex to its base at the cilia, and the surrounding skin is undermined. The lid is righted and the approximating lips of the incision are joined by sutures, the lines of juncture now resembling a Y instead of a V. Tarsorrhaphy may be added, or the lid may be anchored by collodionized strips of gauze to the cheek (if the upper) or to the forehead (if the lower). Such an operation has a great advantage over those like that of Dieffenbach in that it does not call for a further sacrifice of integument, and should have precedence whenever practicable.

Von Graefe conceived the idea of correcting extensive ectropion of the lower lid by making a flap the whole width of the lid and extending downward ten to twelve millimeters. He split the lid into its two leaves, the anterior composed of skin and muscle, the posterior of tarsus and conjunctiva, by an intermarginal incision the entire length of the palpebral fissure. From the ends of this

[1] Technique Operatoire, Paris, 1902, p. 700.

ran two vertical cuts, extending as far as the lower rim of the orbit. The flap thus outlined, was dissected up, the ectropion corrected and the tarsus, together with the overlying flap, forcibly drawn upward. The flap was then joined to the adjacent skin by interrupted sutures, beginning below, for about one-half the distance. The top or elongated corners of the flap were rabbeted (Fig. 166 *a b c*). The upper edge, thus shortened, was put upon the stretch and stitched to the free border of the tarsus, the ends of thread being left long and fastened, in a pad of collodionized cotton, to the forehead. A few shallow sutures were placed in the remaining vertical skin openings and over all a compressive bandage. The chief objection to this operation lies in the fact that new tissue is not supplied to help the graft in supporting the lid.

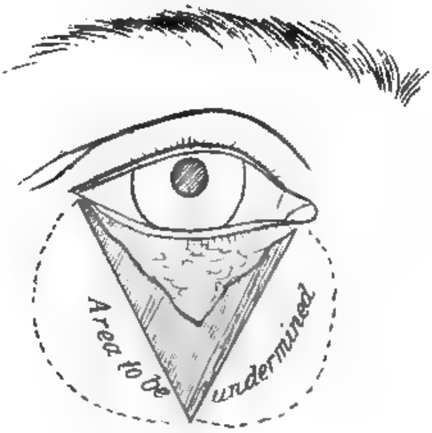


FIG. 164.—Wharton-Jones, No 1.

F. Jaeger[1] devised a thoroughly rational and practical operation for cicatricial ectropion of the upper lid, where the ciliary border was so displaced as to lie close to the supercilia. It may be classed as a sliding-flap method. He made cutaneous incision as long as the palpebral fissure, close to and parallel with the margin, undermined the tarsus and turned the lid down into place. If the border seemed much elongated, he excised from the center a wedge that included the entire thickness and brought together the edges of the notch by means of a surgical pin and figure-of-8 ligature. Figs. 167

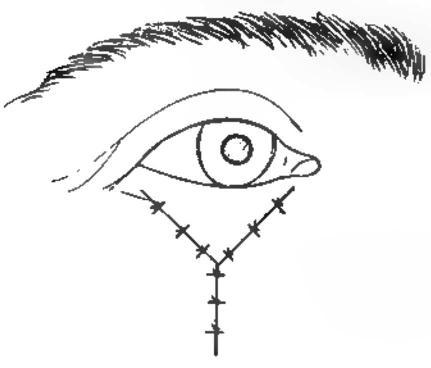


FIG. 165. Wharton-Jones, No. 2

[1] Jaeger-Dryer, Novo blephar. methodus, 1831, p. 28.

and 168). The upper edge of the open ellipse was dissected for a considerable distance, that is, the skin of the entire brow as far as the middle of the forehead and out to the temple was loosened, and the whole drawn down to cover the opening, and the wound closed by sutures.

In the light of modern methods, the triangular excision of the free border alluded to in this operation would be made at the outer

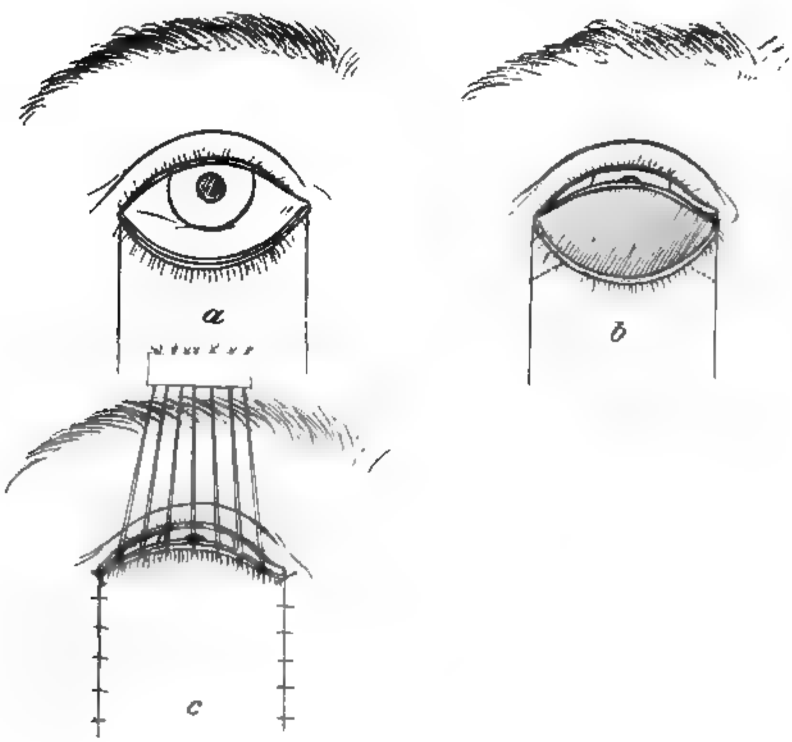


FIG 166.—*a*, *b* and *c*, Graefe's operation for cicatricial ectropion.

canthus, *a la* Von Ammon-Adams, or after the Kuhnt-Müller mode (only in upper lid). The lid would be drawn away down, overlapping its fellow, and fixed to the cheek by collodion, and the large raw opening would be covered either by a pediceled flap or by a graft.

One of the earliest and best examples of a sliding-flap operation for blepharoplasty is that devised by Dieffenbach,[1] while professor

[1] Casper's Woch., Bd. i, S. 8.

of surgery in Berlin, about 1835. The process could be applied to restoration of the outer leaf or of the whole thickness of the lower lid, and was as follows: by removal of the offending tissue, a triangular opening, with base upward, was made below the eye

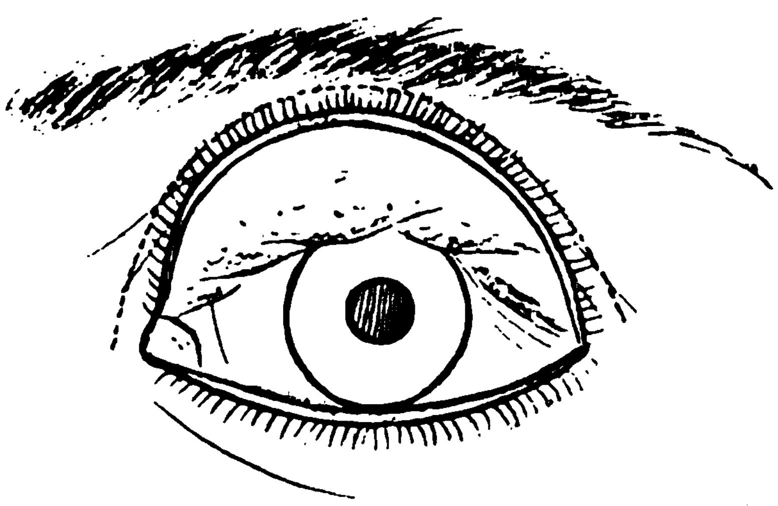


FIG. 167.—Jaeger's operation for ectropion of the upper lid. Dotted line is line of incison.

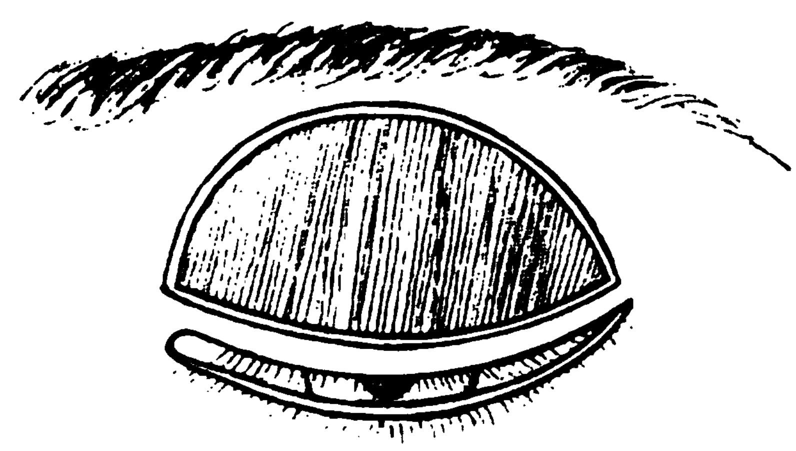


FIG. 168.—Same lid turned down.

(Fig. 169), *abc*, taking care to conserve the conjunctiva. From the outer canthus, extending horizontally outward for a distance equal to the length of the palpebral fissure (or to the base of the triangle), another incision, *bd*, and from the extremity of this one, down and in, and parallel with the outer side of the triangle, still another, *de*. The trapezoid flap thus marked out, was loosened from summit

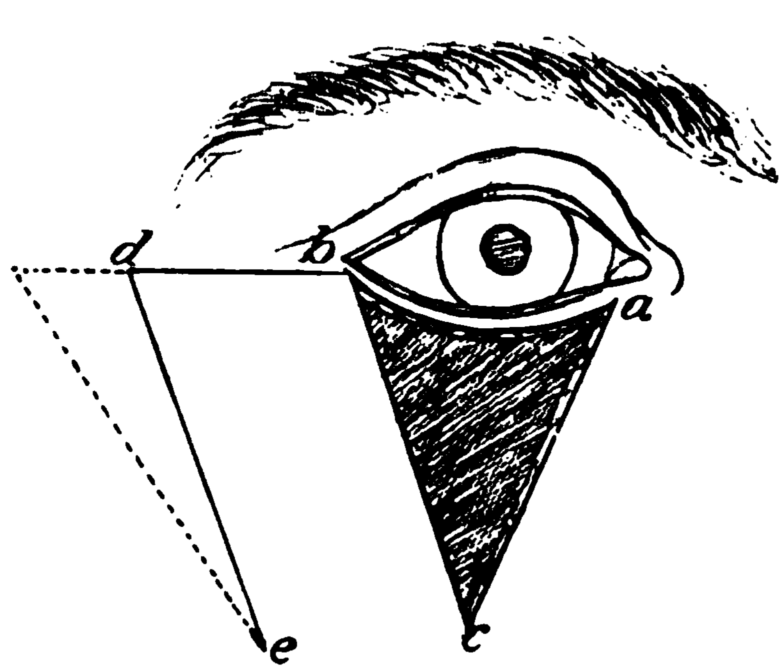


FIG. 169.

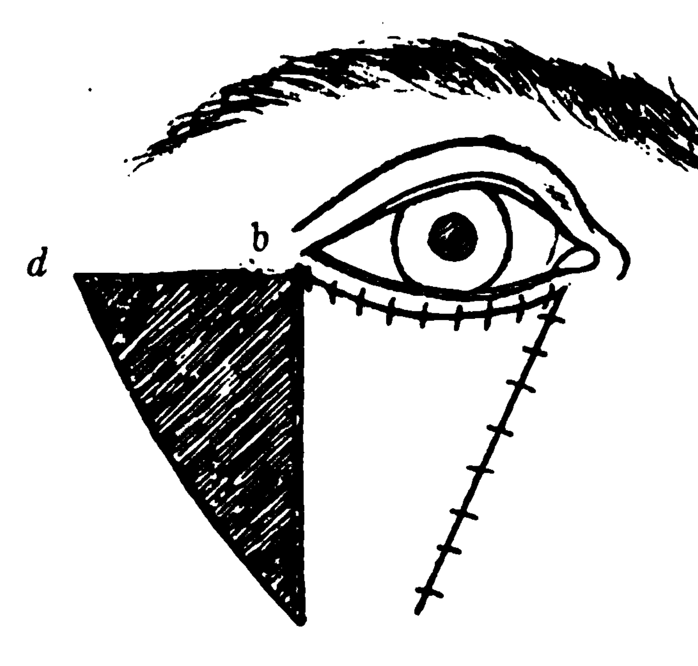


FIG. 170.

FIGS. 169 and 170.—Dieffenbach's blepharoplasty, *e. g.*, in the removal of a growth.

to base, slid over, bringing *b* to *a*, then sutured internally to the skin and superiorly to the conjunctiva. The secondary bared space, *bde*, was left to heal by granulation (Fig. 170). To-day this space would be covered by a graft. Indeed, Angelucci and many others

have so treated this space. Angelucci broadened the top of the flap as shown by the dotted lines, and employed a pedunculated flap from the temple for the secondary defect.

Szymanowsky,[1] with the view to a closer approximation of the secondary defect, and in order to obtain more tissue for replacing loss in the lower lid, extended the incisions according to the dotted lines (Fig. 169). For the restoration of the inner half of the lower lid, Arlt modified the operation as shown in Fig. 171. To avoid the outward stretching of the new lid and the displacement of the external commissure that would result from the Dieffenbach procedure, Harlan,[2] of Philadelphia, made the rather elaborate operation pictured in Fig. 172. The broad space beneath the eye was narrowed as much as practicable by undermining and bringing the lower edges together before sliding the flap into place, and the same was done with the second triangle on the temple. Thus, not only was the secondary defect reduced in size, but so elevated as, by its healing,

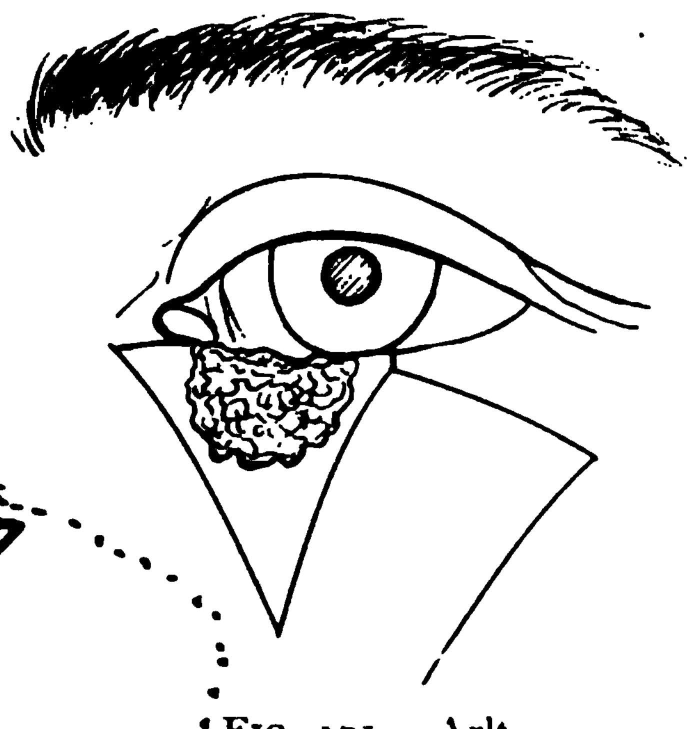


FIG. 171.—Arlt.

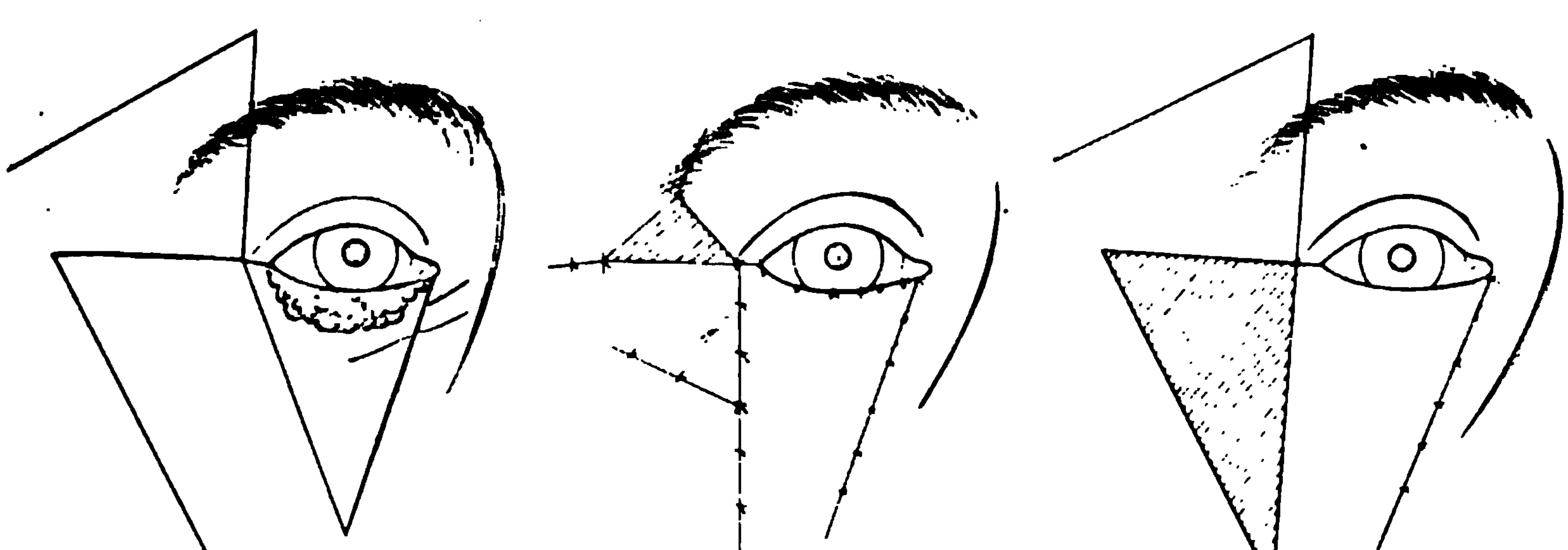


FIG. 172.—Harlan.

not to exert an evil influence on the position of the lids. Another advantage claimed was that, being stitched on either side to sound skin, the nutrition of the new lid was better assured than if, on one

[1] Graefe-Saemisch, iii, S. 476.
[2] Norris and Oliver, p. 117–118, 1898.

side, it were left to form the margin of an extensive granulating surface. Harlan's operation was for an epithelioma involving the entire lower lid. Three years afterward, "the canthus was in normal position and the deformity was slight."

A pure specimen of the **sliding-flap operation** is that devised by Knapp,[1] and made for the repair of a lower lid whose inner

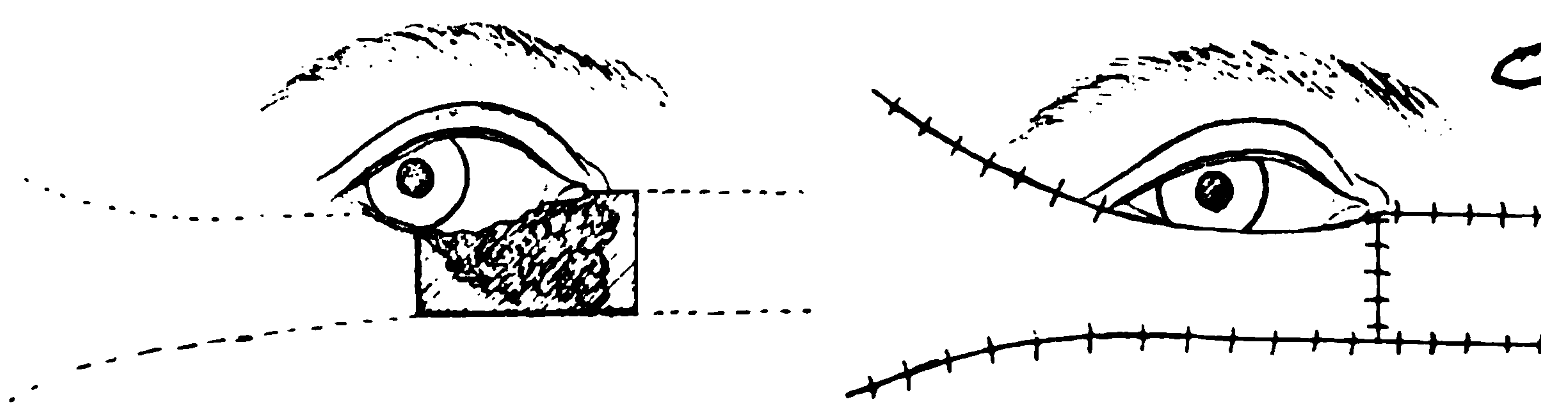
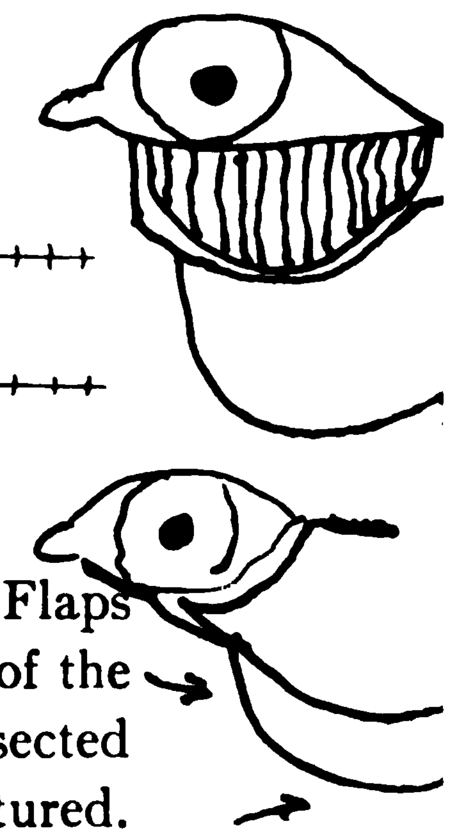


FIG. 173.—Knapp.



two-thirds were sacrificed in the removal of a chancroid. Flaps were constructed as per the lines in Fig. 173. After excision of the section containing the ulcer, the two flaps, having been dissected loose from free end to base, were butted together and sutured. The result was excellent.

As a good illustration of a totally wrong principle in a sliding-flap operation, I would cite the method of Burow.[2] Here the triangle

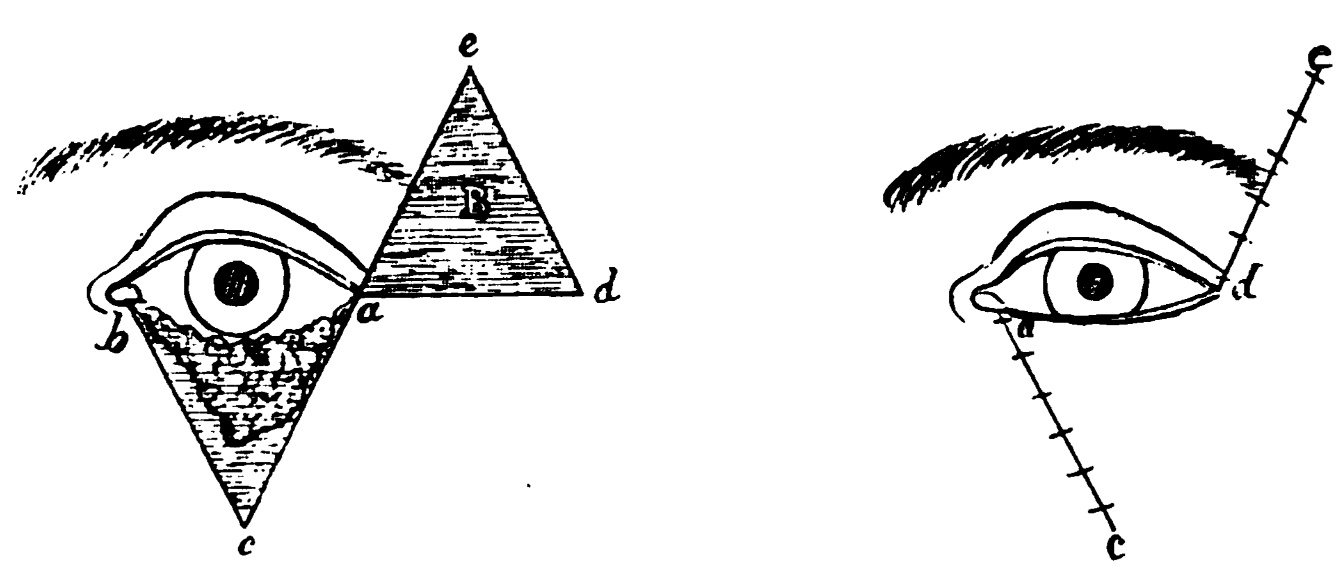


FIG. 174.—Burow.

of skin, *aed* (Fig. 174), is excised and thrown away, in order that, in the mobilized integument, *d* may slide to *a* and *a* to *b* and close the openings. There is no chance of supplying suitable borrowed tissue for the secondary defect. In other words, the loss of tissue contiguous to the eye is exactly doubled. Much more rational is

[1] Archiv. f. Oph. xiii, 1, S. 183.
[2] Berlin, 1856.

the Dieffenbach operation, wherein the resulting raw surface may be covered by a pedunculated flap, cut from skin more remote from the lids, or by a cutaneous graft.

2. **The Indian Method.**—In the ancient days of India there was endless strife between the black races, with their ugly flat noses, and the lighter Aryan invaders, with their boasted nasal prominence and beauty. Hence, the nasal feature soon became the target, not only for ridicule and scorn, but for actual violence—legal and otherwise. Hence also the Hindu surgeons were early in devising means for the restoration of the mutilated organ. Among their methods was that of building up the lost portions of the nose by transplanting pedunculated flaps of skin from the adjoining cheek. When the same was applied to the plastic surgery of the lids, it was referred to as the *Indian method.* Blepharoplasty was not practiced to any extent, however, until the third decade of the nineteenth century, and almost all the earlier attempts were after the Indian method—that is,

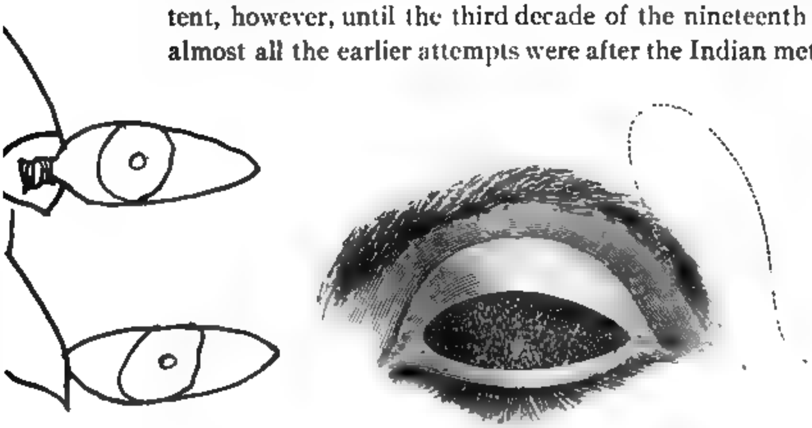


Fig. 175

by rotation of pedunculated flaps, taken from the nearby skin, with more or less twisting of their pedicles. The first to claim having successfully restored a lid in this way was Carl Ferdinand Graefe.[1] In 1818, this surgeon, after several years in trials of various means, reported some of his experiences. Among them was the building up of the lids by both this and the Italian methods. In the same article (p. 19) it is stated that Dzondi had essayed the renewal of the lower lid by a flap taken from the cheek, but had failed.

[1] Journal of v. Graefe and Walther, II, p. 18.

The procedure was systematized and given its first real impetus by Fricke.[1] His operations related mainly to the correction of cicatricial ectropion the tarsus, conjunctiva, and free border having been intact. Fricke's perfected operation was as follows: given a case of complete cicatricial ectropion of the upper lid, for example,

FIG. 176.

an incision was made between cilia and supercilia, parallel with the rim of the orbit, the tarsus loosened from its attachments, and turned down into place, thus leaving an oval raw surface (Fig. 175). A flap, somewhat larger than the oval, was cut from the forehead and temple, whose base, broader than the body of the flap not a

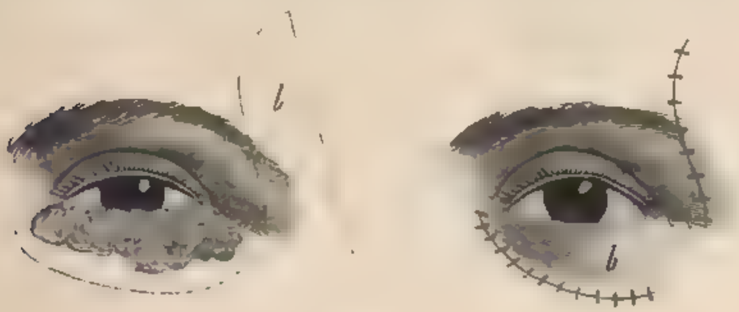


FIG. 177.

pedicle in the strict sense of the word was situated a little external to the margin of the orbit and slightly above the operated lid. Before turning the flap into its new position, the bridge of skin between the two raw areas was excised sufficiently to receive the

[1] Bildung neuer Augenlider nach Zerstorung und dadurch hervorgebrachter Auswartswendung derselben Hamburg, 1829.

pedicle or base. It was found that this was more satisfactory than to allow the pedicle to lie on top of an isthmus of skin, with the view of cutting and trimming it later. The flap was held in place by numerous sutures, and the gap from whence it came, or the secondary defect, was left to heal by granulation.

FIG. 178.—Denonvilliers

FIG. 179.—Denonvilliers.

So far as it goes, this operation of Fricke is essentially the same as performed by his successors and by many surgeons for the same deformity to-day. The variations have been mainly as to the region from which the flap was taken—this has been covered but

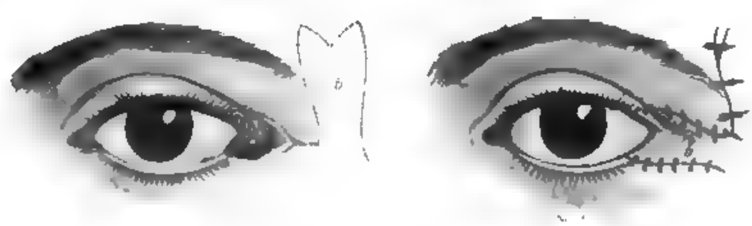


FIG. 180

in what manner is a matter that has been governed by the judgment of the operator and by the peculiarities of the case.

Blasius,[1] for the restoration of the entire lower lid at one time, took a flap, pedicle inward, from the side of the nose and the forehead. (Fig. 176.) At another time, for replacing the lower lid, pedicle

[1] Med. Zeit, März 1842

outward, from the temple and forehead (Fig. 177). For an extreme ectropion of the whole lower lid, Denonvilliers utilized an enormous flap, cut from in front of the ear, with pedicle just external to the outer canthus (Figs. 178 and 179). For the reparation of an angular loss of substance—external or internal—the

FIG. 181.—Hasner.

bifurcate pedicle, as first employed by Hasner, serves admirably (Figs. 180 and 181). For a yet more elaborate restitution of a commissure, the process of Richet[1] is cited. The primary defect was an inferoexternal ectropion, from an adherent scar of the orbital rim, with fungus growth.

After crescentic excision of the diseased portion *a* and righting

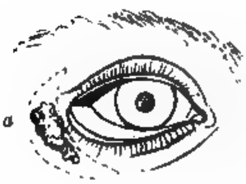


FIG. 182.—Richet.

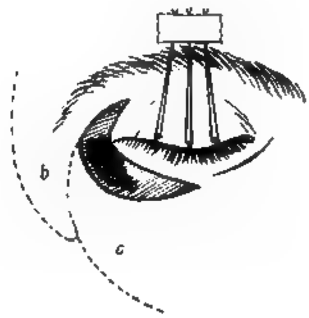


FIG. 183.—Richet.

of the lid (Fig. 182), a provisional tarsorrhaphy was made and the threads were attached to the brow by collodion. Next, the flaps *b* and *c* were fashioned (Fig. 183), which were interchanged and sutured to cover the defect as shown in Fig. 184.

[1] Recueil d'ophtalmologie, 1873.

Some years ago, I[1] reported the restoration of the entire right lower lid and the outer third of the upper by a mitten-shaped flap formed from the cheek. The breadth of the mitten was so great at its widest portion that it was impossible to approximate at this point the edges of the secondary defect, and a cutaneous graft, taken from the arm, was put in to fill the space; Fig. 185 shows the result three years after the operation. The case was that of an elderly woman, and the parts had been destroyed by a rodent ulcer.

In place of borrowing skin to one side of a commissure, above or below, as in the examples just given, the flap has been taken from one lid to replace tissue lacking in the other. Landolt[2] made from the upper lid a bridge, or double pediceled flap, to restore the lower lid that had been destroyed by a carcinoma. An incision was made through skin and muscle, two millimeters from and parallel with the upper margin, and extending at either end somewhat beyond the canthus. This was repeated seven or eight millimeters higher up, and the intervening strip of skin and muscle was loosened throughout its length, except at the ends. The conjunctiva was separated from the lower free border, from canthus to canthus, sufficiently to receive the flap, which was transposed to fill the gap and there stitched. The upper lip of the superior opening was undermined, and the skin drawn down and sutured to the lower lip. At the proper time the pedicles were cut and trimmed to fit (Fig. 186).

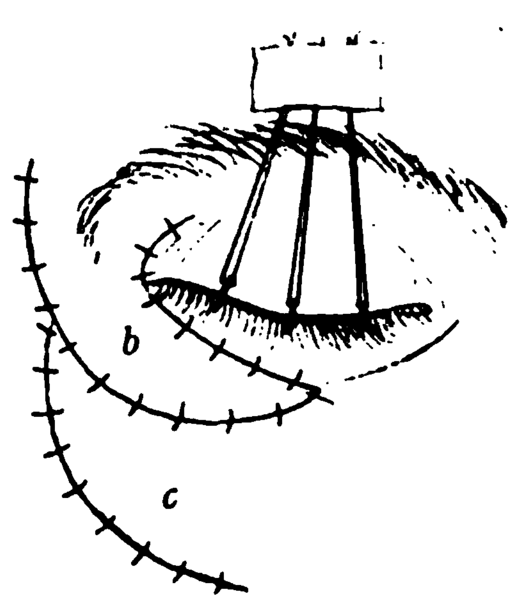


FIG. 184.

Panas[3] made a regular practice of taking from one lid and giving to the other, though through a single pedicle left near the outer canthus, and he usually subjoined provisional tarsorrhaphy. This robbing of Peter to pay Paul would seem hardly justifiable if suitable tissue for the flaps could be found outside the longitude of the palpebral fissure, for the reason that *it is inadvisable to have the bulk of the secondary defect contiguous to the lid margins.*

[1] Am. Jour. of Ophthalmology, June, 1897.
[2] Archiv. d'opht, 1885, p. 492.
[3] Clin. opht., 1899, p. 31.

This brings us to a consideration of such questions as the preparation of the lid and the selection and outlining of the flap. Besides the principle just stated, there are a number of others to be observed in this connection. Before proceeding to mark out the skin that is to be transplanted, its new site is opened up and carefully prepared, so that its size and shape may be apparent, and all bleeding may be stopped in due time. If, as is most often the case, the operation

FIG. 185.

is for the correction of ectropion, an incision is made through the skin, three or four millimeters from the free border, whose length somewhat exceeds that of the everted part. The lips of this immediately retract, and the opening thus formed is deepened till muscle or underlying fascia is reached. The free border is seized by fixation forceps and pulled toward its normal position, the dissection being meanwhile carried toward the convex border of the tarsus. The latter and the orbicularis are spared; that is, the restraining cicatricial bands are divided without cutting

the muscle and the tarsus, and the anchylosis between the tarsus and underlying tissue is entirely freed. "The removal of all scar tissue," once thought imperative, is no longer so rigidly insisted upon. The harder masses are best gotten rid of, perhaps, but to attempt the excision of all of it is not feasible.

The same allowance is made for the subsequent contraction of the oval bared space thus created, as for that of the skin that is to cover it. Hence, this preliminary opening up is made extreme; to such a degree, for example, that for complete ectropion of the upper lid its free border would overlap the lower lid and lie upon the cheek, opposite the inferior portion of the rim of the orbit or even below it. The more recent the injury that caused the misplace-

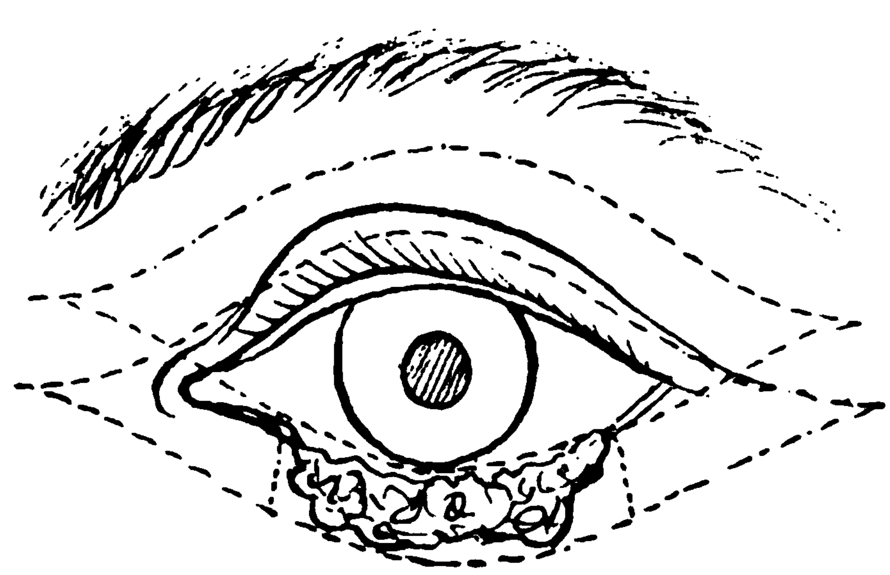


FIG. 186.

ment, the greater must be this overeffect. If the operation is to restore the lid after removal of a growth, or the excision of an ulcer that involves the whole thickness, the conservation of the maximum amount of the conjunctiva is important.

For the entire upper (or lower) lid or any part external to the middle, the pedicle is best situated about on a level with, and close to, the outer canthus, and the long axis of the flap should be directed upward (or downward). Some of the older surgeons have advised that a flap to replace the upper lid be taken from the malar region, and one for the lower from the temple, for the reason that the strain of cicatrization in the secondary defect will, in this arrangement, tend to enhance the desired effect. As regards the body of the second bared space, however, it signifies but little, yet, as concerns the position of the *pedicle*, it *does* make a difference. On account of its proximity to the original defect, to elevate it for the

lower lid and to depress it for the upper, contributes to its success. Moreover, in male subjects, it is difficult to fashion a flap from the cheek without including the hair follicles of the beard, and the presence of hairs in the flap—no matter how few or small they may be—is objectionable. Yet we have seen patients exhibited with great gusto who had been furnished with a new set of eyelashes borrowed from the supercilia. For circumscribed defects situated more toward the nasal side of the lids, the glabellar and nasomaxillary regions offer the more fitting skin for pedunculated flaps; and whether or not they are taken from the former for the lower lid and from the latter for the upper, as advised by many surgeons, the pedicle at least should be slightly higher than the canthus when the lesion is of the lower lid, and *vice versa*. If only scar tissue is available for the flap, it also may be utilized, provided it is superficial, movable, and not too greatly contracted.

In the matter of choosing a flap, it is often not so much a question as to what one would *like* to have, as what one can *get*. In cutting the subsidiary integument, if it lies close to the inner canthus, the lacrimal canal is to be respected, and if in the malar or infrazygomatic region, the duct of the parotid gland is to be avoided. As has been intimated already, the pedicle should be situated as near as practicable to the primary defect, and the body of the secondary defect more remote. If a desirable skin area can be reached by moderate elongation of the pedicle, it may be so extended, but a roadway or bed should be opened through the intervening bridge of skin where to *inlay* this long neck, rather than have it lie on top. It is hardly proper to refer to the pedicle as a *neck*, seeing that such a term implies a considerable narrowing. It were better, perhaps, to call it the base of the flap, since to be adequate for the nourishment of the rest of the peninsula, this portion must be little, if any, narrower. Slender pedicles and long-drawn-out points to flaps are both serious faults, as they favor gangrene. For the pedicle to be skimp, as to length, is equally grave. This means undue stretching and constriction. It would far better be too long than too short, especially as more or less swelling is to be expected after the operation. It is well to remember that the greater the degree of torsion of the base required to put the flap in place, the greater the amount of shortening, and allowance must be made accordingly. Indeed, it

were prudent so to lay out the flap as to necessitate the minimum torsion in rotation—all things else being considered—as this alone tends to strangulation.

It pays to study carefully the original cicatrix, particularly with the view to ascertaining the lines of greatest strain. Here is where the overeffect must be most pronounced, which concerns both the preparation of the lid—extensive opening up; and that of the flap—surplus width at the points indicated.

FIG. 187.

Provisional tarsorrhaphy has been extensively practised as an adjunct to blepharoplasty. In the correction of cicatricial ectropion, however, where the repair is made with flaps or grafts, the procedure so far from being of advantage, is a positive detriment, in that it prevents the getting of that very pronounced primary overeffect which is an indispensable element of success in these operations. No doubt, the employment of it has had much to do with the discouraging experiences so many surgeons have had in such surgery.

In order that the ultimate result of an operation for cicatricial entropion, of the kind in question, may be sufficient, not only must the eversion be rectified, but the opening up of the ellipse whereby the correction is brought about, must be so extreme that the border of the operated lid lies considerably beyond that of its fellow. If it be the upper lid, the free border reaches the lower rim of the orbit; if the lower, the lid margin reaches the upper corneal limbus. Sutures are seldom required to maintain the lid in position if these

FIG. 188.

principles are observed, and when put in may do more harm than good. Neither have I found a place for the excision of a gore from the free border that is so often referred to. Whatever elongation of the edge of the lid that may be present at the moment, will surely disappear in the healing process.

Figs. 187, 188 and 189 refer to a case of total ectropion of the lower lid corrected by the author. Here the Wolff graft when taken from the arm measured three by four inches. The elliptical bared space left after righting the lid measured one and one fourth

by two and one half inches. On account of its great size and weight, where the upper edge of the graft was stitched to the free border of the lower lid, the suture ends were left long and fastened to the forehead by collodionized gauze (Fig. 187). Fig. 188 shows the result one month later. Fig. 189 shows the arm defect and bracket incisions in which Thiersch grafts have been planted.

FIG. 189

The Preparation of the Flap.—Having opened up to the fullest extent, and otherwise put in readiness the place that is to be repaired, and covered it with a pad of cotton, wet with boric-acid solution, an exact pattern of it, as to size and shape, is cut out of a piece of sterilized gold beaters' skin, tin foil, or gutta-percha tissue. This is laid on to the integument chosen to supply the subsidiary tissue and the flap is outlined, except at its base, with the point of a scalpel. To do this an incision is made, through the epidermis only, parallel

with the edge of the pattern and at least one-half a centimeter from it.

In order to allow for both the marked primary and the very considerable secondary shrinkage, the flap is none too large if the area marked out is at least twice that of the pattern. If the incision is of the right depth, the flap will be defined by a tiny line of blood. From the base the lines that form the pedicle are extended in the direction of the defect. The incision is then deepened, until it reaches the superficial fascia, i.e., it includes the skin and the subcutaneous fat, and the whole (adipose and all) is dissected up by means of blunt-pointed scissors. The dissection is begun at the apex, using forceps to hold while cutting. As soon as the end is sufficiently loosened, the fingers, clad either in cots or gloves of thin rubber, are substituted for the forceps. In this way there is less bruising of the flap, and one is enabled to use the scissors with greater precision. The dissection is carried well to the base, but the final fashioning of the pedicle, at its nearest point to the defect, is left until the flap is turned into its new position, so that the incisions may be so modified as to produce the most favorable adjustment, the least stretching, etc. The parts are flooded, from time to time, with quite warm boric or salt solution. Whatever bridge of skin that separates the two defects is incised and retracted to make a groove into which to countersink the pedicle (inlaying).

After trying and insuring the fit of the flap and pedicle, these and the beds in which they are to lie are given their last attention, all bleeding is stopped, all clots removed, and they are put in the best possible coaptation throughout. Especially must it be seen to that there are no air spaces beneath the flap, and that its edges are not left curled under, as they are strongly inclined to do. The fewer the sutures inserted to fix the flap, the better. Their introduction causes injury of the flap, through mangling and strangulation; also bleeding of the skin to which it is stitched, and thus the risks of failure are multiplied. One at the extremity may be required, but good sitting flaps will often need none at all, the dressing alone sufficing to hold them in place. Where the entire substance is lacking, it is necessary, of course, to unite the edge of the flap to the conjunctiva by a series of fine sutures.

It has been recommended by high surgical authorities that,

before fixing the flap in place, the edges of the secondary defect should be approximated, lest the stretching of the skin around the primary defect, consequent upon the latter procedure, should call for a different disposition of the flap. To the writer this seems both inexpedient and inconsistent, for the reason that it is virtually making a nice and propitious arrangement of the flap—really the essential part of the operation—secondary to the closure of the gap from which it was taken. Believing, therefore, that it is more conducive to favorable results, I try to get the flap into position with the least possible delay and to leave it undisturbed. To this end, I at once cover it with the thin sheet of cotton wet with warm boric acid solution and leave it thus while attending to the flayed space, where, in bringing the edge of skin together, the undermining and traction are so made as not to affect the operated lid. If absolute union of the edges cannot be brought about without undue stretching, a Thiersch or a Wolfe graft is put in to piece out, either at once or a few days later.

The dressing consists in the usual thin sheet of cotton, wet with hot *saturated* solution of boric acid, made large enough to cover the whole field of operation. A large pad of dry cotton is built upon this, over this is laid a piece of non-absorbent material like gold beaters' skin or oiled silk to prevent dryness, and over all, the regulation wet netting bandage (see chapter on Dressings). It is better to occlude both eyes for the first forty-eight hours, at the end of which period the dressing is first removed. This is done under free irrigation with warm boric acid solution. Any sutures that may have been put in are then removed and the bandage reapplied. From this time the unoperated eye may be left free. The other should be kept bandaged, with daily changing for purposes of cleanliness and inspection, for about ten days or until a new layer of epithelium has formed on the flap. Too early exposure to the air leads to extra shrinkage and to dry gangrene. Even after the bandage is discontinued, it is well to protect the graft for a time by a film of sterile vaselin.

Ectropion from bone lesions of the orbit offers special difficulties. Those cases occurring, for example, as a result of fracture of the infero-temporal rim, with infection, the formation of sequestra, caries, etc. It may be that both the outer tables of the bone -the

one on the malar, the other in the orbit—are destroyed, and between them is left a deep adherent cicatrix or cleft. To excise the depressed integument avails nothing, for the excavation is promptly repeated.

For this class of cases, Tripier[1] has given an ingenious surgical procedure. The sunken, scarred, soft parts are excised. On opposite sides of the opening, two ring flaps are fashioned, each somewhat greater in area than half that of the cavity, bases toward it. These are turned over, epithelial surfaces inward, i.e., looking toward the cavity, and their edges brought together. From the most available portion of the nearby skin is made a bridge flap, large enough to cover the entire defect, which is slid on, and the secondary defect closed by undermining and approximating the borders. The latter consists, of course, of the raw surfaces of the wing flaps plus those of the places from which they were taken. By this method is sought not only the righting of the lid, but also the filling up of the cleft. The only other alternative is to let the scar alone, return the lid to its normal position in the usual way—by incision parallel with its free border and dissection—and fill the gap with a flap or with a graft.

Czermak advises that after operations necessitating a moderate loss of bone in the orbital rim, the plastic operation be not resorted to at once, as often such healing can be brought about as either to avoid it altogether or to require only a slight surgical procedure, such, for example, as the subcutaneous division of the adherent scar, followed by massage. The same author remarks that after the removal of an epithelioma or other malignant growth from the lids, the opening be left uncovered for a time, so that a recurrence may be early detected and promptly dealt with, arguing that, if hidden by the borrowed integument, it could attain inconvenient dimensions before being discovered. This might be well enough if the growth were situated deep in the inner angle, where it could readily extend into the lacrimal fossa or into the accessory sinuses of the nose. As a rule, it is better to make the plastic operation at the same sitting.

3. **The Method by Cutaneous Grafts.**—As applied to plastic surgery of the eyelids, this method is of recent date, yet, like that of

[1]Rec. d'opht., 1890, p. 129.

pedunculated flaps, in its relation to certain other features, as rhinoplasty, for example, it is of ancient origin. It, too, was practised by the ancient Hindu surgeons. The grafts are referred to as *dermic* or *epidermic*, according as they comprise the entire thickness of the skin or only the epithelial layers.

Dermic Grafts were first used in blepharoplasty by Le Fort.[1] His earliest attempts were with pieces of skin cut from the arm, that included the fat, and were large enough to cover the entire defect. As they were mostly failures, he conceived the idea that they were too thick. With this in view, in subsequent trials he pared down the grafts at the back, removing the adipose and part of the connective tissue, and had the satisfaction of seeing them survive.

In Great Britain and America the process was popularized through articles by Wolfe,[2] of Glasgow, in which he reported successful blepharoplastics with the Le Fort method and gave original details as to technic. The dermic graft is, therefore, referred to in these countries as the *Wolfe graft* and on the continent of Europe, as the *Le Fort-Wolfe*. It may be added that the method has never ceased to find favor in the eyes of English-speaking ophthalmic surgeons, having attained, in the United States, a specially strong footing, where it is employed with almost as much confidence as is that with pediceled flaps. In truth, it is often chosen in preference to the latter to obviate the extra scar on the face. Their thickness or *body*, renders them peculiarly fit for replacing loss of substance in the lids. In France and Germany, however, it is pretty generally decried, except as a last resort, a method of *necessity* and not of *choice*, i.e., only employed when suitable material cannot be obtained, in the form of flaps, from the neighboring integument.

Valude,[3] for instance, speaks discouragingly of it, having operated seventy-seven times, using Wolfe grafts for the loss of substance, with but fifteen successes. Whatever may have been the chief causes leading to the failures of our European colleagues, it is certain that immensity of grafts and of perseverence did not figure largely among them.

The habitual vice of the graft in question is *shrinkage*. Its

[1] Bull. de la Soc. de Chir., 1872, p. 39.
[2] Brit. Med. Jour., 1876, and Med. Times and Gaz., vol. vii, p. 608.
[3] Archiv. d'opht., T. ix, p. 289, 1889.

average capacity in that line is enormous, to offset which its original size must be proportionately vast. This is the master key of the situation. Yet knowledge of, and heed to, this property do not always suffice, even when accompanied by the utmost precision in all other respects. Here is where *persistence* comes to the rescue. Some of the most gratifying results are obtained only after repeated operations, each one as extended and thorough as its predecessor.

According to the observation of C. Garré,[1] the really useful part of the graft is limited to the deeper layers of the epidermis, and to transplant the corium, which is destined to undergo connective-tissue degeneration, merely retards the union of the Malpighian portion with the underlying vascular network and favors excessive ultimate contraction.

As a further proof that the last word with regard to the dermic grafts has not been said—that there resides therein some subtle beneficent quality that will one day be regularly utilized—cases can be cited wherein this bit of borrowed skin has neither shrunken nor degenerated, but has regained its color, almost immediately after being transplanted, and has not changed so much as to even shed its epithelium. This has happened several times in my practice. But with our present knowledge, the Wolfe graft is expected to shrink more than any of the other varieties, both primarily and secondarily. As a rough estimate, one might state the total contraction, from first to last, at something like 75%. Hence, in outlining the graft, the area inclosed would be about four times that of the defect to be covered.

Panas[2] states that one condition particularly favorable to success of all autoplasty is the implantation of the flap or graft in the midst of a plaque of scar tissue. Thanks to the retractile nature of the cicatrix, an incision or opening made therein, instead of narrowing or shrinking, actually expands, even to the extent of acquiring double its first area. Nélaton, who first called attention to this important fact, also observed that in order to give the opening this quality the flap (or graft) should rest on normal tissue. Thus it comes about that in palpebral autoplasty after burns, for example, a flap, appar-

[1] Beiträge z. klin. Chir., iv.
[2] Maladies des Yeux, 1894, t. ii, p. 174.

ently inadequate, may serve for the complete reparation, provided. one takes care to remove all scar tissue from the place it is to occupy. This is not always feasible, especially when the cicatrix is very deep or adherent to bone. In such cases some operators (Wicherkiewicz among them) advise secondary grafting, i.e., not applying the supplementary skin until the defect is well covered with granulations. Removal of scar tissue from the defect is more urgent in graft methods than in those with sliding or pediceled flaps.

The size of the graft is limited only by that of the bared space it is to occupy. In fact, a single piece, sufficiently large, is preferable to two or more smaller ones. De Wecker[1] with the idea of better insuring the survival of the transported integument, tried cutting it into squares whose sides measured from one-half to one centimeter, which were placed on in the form of a mosaic; but it was found that the small fragments did not "take" more readily than larger ones, and, moreover, shrinkage and scarring were greater.

Preparation of the Dermic Graft.—The lid defect is put in readiness the same as for a flap, save that in case of the graft the primary effect must be yet more extreme. A certain area of the delicate, hairless skin at the inner side of the upper arm or of the leg or thigh is washed with green soap and boiled water and thoroughly rinsed with boric acid or salt solution. The skin over the inner border of the left biceps (of right-handed patients) is probably the most suitable, all things considered; yet in the case of a feminine subject likely to take pride in bare arms, the thigh would be a better location for the scar. The graft is outlined with the aid of the pattern as per the instructions for the flap, except that the ratio of its size to that of the defect should be about fourfold, instead of double, and, there being no pedicle, of course the pattern is completely surrounded by the incision. The usual shape of the section of skin is that of an ellipse, or oval, and as it is important that the long axis of the graft coincide with that of the defect. Orientation is facilitated by first dissecting up the extremities of the oval and putting a fine suture through each from the epithelial side. If this is not done the primary shrinkage is so great the moment the piece is excised that it is then difficult to place it properly. As soon as one end is loosened enough, the cotted or gloved fingers are

[1] Annal. d'oculist., 1872, p. 62.

substituted for the forceps to hold the piece, and the entire dissection is completed with the blunt scissors, exercising care to avoid injury to the basilic vein.

Should the skin on the inner aspect of the thigh, just above the knee, be chosen, which is probably the next most fitting, cutting into the long saphenous vein is to be guarded against. These two large veins can be seen through the skin, as they lie just beneath the superficial fascia.

Unlike the flap, the graft after having been severed is freed from all its adherent fat. It is then dipped in boric or salt solution or not as the judgment of the operator shall decide, laid on, according to its dimensions, and carefully spread out. The contained sutures are inserted at the corresponding ends of the defect and tied. Additional sutures are put in only where they would seem to be absolutely necessary. If, as often happens, the graft adjusts itself nicely to its new location, these are best omitted. The dressing and after-treatment are identical with that described for pedunculated flaps.

Until the lid operation is finished and the bandage is applied, a pad of cotton wet with sublimate solution, one to three thousand, is kept on the wound in the arm. Since before Urban[1] signaled their abandonment in this particular, the writer has never allowed mercuric solutions to come in contact with the graft nor with the operated lid, because of their coagulating effect and the damage they inflict upon the epidermis. The last attention having been bestowed upon the eye, the edges of the opening in the arm are widely undermined and approximated by interrupted sutures. Should this require undue tension upon the skin, it is relieved, where greatest, by bracket incisions (Fig. 189), or, preferably, the opposite edges of skin are approached only so nearly as practicable, one to the other, and the gap afterward filled with a Thiersch graft. If bracket incisions are made, the spaces between their lips may be similarly covered. Iodoform powder is dusted on, iodoform gauze laid on, then a pad of cotton, and over all a muslin or wet netting bandage. Every precaution should be taken to prevent disturbance of both the eye and the arm dressings. A good way is to fix the bandages in place with flexible collodion, as described

[1] Deutsche Zeit. f. Chir., 1892.

under "Eye-dressings." It is well to fix the arm in a sling beneath the clothing, the better to guard against exposure of its wound, which is quite prone to infection.

The graft is at first blanched, but at the end of twenty-four hours, if it has "taken," something like its normal tint is present. A little later—say on the second day—it becomes of a rosy hue. About the end of the third day begins the shedding of its epithelium, when it again appears whiter. After this process is completed the patch takes on a color that is, for a time, redder than that of the surrounding skin, but its ultimate color is a shade whiter than that. If the transplanted tissue or any part thereof perish, it may be from one of several causes, chief among which are gangrene (white, livid, or dry), secondary hemorrhage beneath, stitch-canal or superficial infection, phlegmon, and erysipelas. These are all accidents that either happen very early or not at all. A later sequel, coming sometimes many days after the graft has become viable, is a progressive ulceration. For sloughing, hemorrhage, and gangrene, little can be done. Infections are to be treated by removal of sutures, copious and frequent irrigations with mild antiseptic solutions used quite warm, etc. An excellent remedy for the ulceration alluded to is the painting of the raw surface with a 12% solution of silver nitrate, followed by thorough washing with warm salt solution.

Epidermic and Dermo-epidermic Grafts.—The epidermization of parts denuded of skin was first conceived and accomplished by the distinguished surgeon, Reverdin,[1] of Geneva. To assist and hasten the healing of certain indolent varicose ulcers, Reverdin cut, with a lancet, from the skin of a limb, epidermic flaps, which he subdivided into bits containing only a few square millimeters, and deposited them on the granulating surface in the form of small disseminated islands. It was demonstrated that the method stimulated the cicatrization in raw surfaces of limited extent, but was less efficacious for larger ones.

To better meet the latter condition, Ollier[2] made the grafts of considerable size—ten to fifteen millimeters long, by one to three millimeters wide—and purposely included a portion of the corium (*dermo-epidermic graft*). He carefully removed all cicatricial

[1] Bull. de la Soc. de Chir., 1869.
[2] Comptes rendus de l'Acad. des Sciences, 1872.

tissue in the preparation of the defect to be repaired, and waited for the surface to granulate before applying the graft. The latter was held in place by strips of diachylon plaster. This species of cutaneous graft was first employed in blepharoplasty by Lawson.[1] In preparing it, the skin may be separated from its original location, as directed for the Wolfe graft, and then pared down very closely with a razor, cutting well below the epidermis. Thiersch[2] adopted the method of Ollier, but with certain modifications, the most important among which was that he declined to implant the graft upon a granulating surface (*secondary grafting*), placing it rather upon a freshly prepared raw one (*primary grafting*). If granulations were already present, they were shaved off to conform to the principle in view. This, according to the same author,[3] is that granulations make an unfavorable base for the transplanted integument, for the reason that they of themselves produce a layer of scar tissue. He also made the pieces thinner than did Ollier.

Eversbusch[4] advised that this form of graft be cut as thin as possible—translucent in fact—the blade of the knife or razor showing through during the section. This constitutes the true *epidermic graft*, known in this country under the name of Thiersch and in Europe under that of Thiersch-Eversbusch. While it is less effective, owing to its lack of body, for the restoration of the lid than the Wolfe graft, it has the advantage in most instances of shrinking less. In point of ability to survive, the two varieties would seem to be about on a par.

Whether concerned immediately in the lid operation or not, the transplanting of epidermis will often be found a valuable adjunct thereto, as, for example, to make a patch when, after a few days, a flap or dermic graft chances, through ulceration or other mishap, to have its epithelium destroyed or when an unavoidable gap remains in a secondary defect.

The Thiersch method is as follows: the primary defect having been prepared as for the flap of the Wolfe operation (or if granulations are present, they are removed), the inner side of the upper arm or of the lower third of the thigh, is washed with soap and sterile

[1] Lancet, Nov. 19, 1870.
[2] Berlin. klin. Woch., 1874.
[3] Arch. f. klin. Chir., Bd. xvii, 2, S. 318, ff.
[4] Münch. med. Woch., 1887, Nr. 1, u. 2.

water, rinsed with boric acid solution and thoroughly dried with gauze—not with cotton, on account of the loose fibres that cling to the parts. The thigh offers fewer difficulties to the cutting of the graft because of its slight convexity, and might be preferable to the patient as the site of the resulting scar. The chosen skin is put moderately upon the stretch, while with a keen, long-bladed razor, *that has been thoroughly boiled*, enough of the epidermis is shaved off—if possible, in one place—to cover the entire defect. It greatly facilitates the severing of the graft to have both the razor and the skin *perfectly dry*. The blade is held flat and firm and the cutting is accomplished by a long, slow, sawing motion. When properly done, the blade of the razor can be seen through every part of the graft, and the resulting raw surface is thickly speckled over with tiny bleeding points that mark the spots where the tips of the more prominent papillæ have been cut off. To cause the skin to present a flat surface to the razor I have profited by an ingenious suggestion of M. L. Harris, of Chicago, whereby a straight-edged object, such as the lid of a cigar-box, is dragged along in advance of the razor. The graft is at once laid on where needed, without previous dipping into boric or salt solution, and slid directly from the razor on to the defect. Here it is nicely spread out, after which any overlapping edges are trimmed with the scissors to fit. Few, if any, sutures are put in. The usual dressings, comprising a thin lamina of cotton, wet with hot, saturated solution of boric acid, next to the skin, a thick pad of dry cotton so built on as to prevent undue pressure on the graft, over this a generous piece of gold beater's skin, tin foil, or gutta-percha tissue, and over all the wet netting bandage, fastened on with flexible collodion.

For fear of carrying syphilitic, or other infection, grafts ought never to be taken from another individual if they can be gotten from the patient.

An effective method for the disposition and fixation of cutaneous grafts in operations for cicatricial ectropion is that of Hotz.[1] In order to prevent the shrinkage of the graft from acting with full force upon the free border, he divides the wound area into two sections, one representing the bared surface of the lid proper and the other that beyond the lid, each of which he covers with a separate

[1] Archives of Ophthalmology, vol. xxxii, No. 3, 1903.

Thiersch (or Wolfe) graft. The lid graft is anchored by sutures to the strip of skin at the free border of the tarsus (upper lid) or to the tarso-orbital fascia beneath the tarsus (lower lid). The second division of the bared space is then covered by an unsutured graft. Before implanting the grafts, two strong silk threads are put through the edge of the reposited lid, it is made to widely overlap its fellow, and the threads are fastened to the cheek (or brow) by collodionized cotton or gauze. By thus fixing the edges of the lid graft to firm supports, both its shrinkage upon itself and its traction upon the free border are counteracted. Moreover, by this arrangement, the contraction of the ultratarsal graft is not so directly transmitted to the tarsal one.

FIG 190.—Hotz.

FIG. 191.—Hotz.

In some instances, Hotz, instead of transplanting a graft to cover the tarsal portion, utilizes the cicatricial skin already overlying it, which he dissects up in the form of a semilunar flap that is left adherent along the lid margin. The bands of scar are divided, the lid is turned into position, drawn over its fellow, and fixed by ligatures and collodion as just described. If it be the upper lid, the free border of the flap is stitched to the upper border of the tarsus; if the lower, to the tarso-orbital fascia and the remaining wound surface is covered by a Thiersch graft into which no

sutures are put. If there is decided elongation of the free border, a portion is resected at the outer canthus (see Figs. 190 and 191).

4. **The Italian method,** or autoplasty by means of a pediceled flap taken from a distant part of the body. This, like blepharoplasty by cutaneous grafts, is applicable to cases where the destruction of the lids and the adjacent skin is such as to render the use of the local integument impossible or undesirable. The method was invented several centuries ago by a Sicilian surgeon of the name Branca, and practiced by himself, and afterward by divers other members of the same name and family for the restoration of the nose. It has also been known as the Tagliacotian method, in honor of Gaspard Tagliacozzi, who, in 1597, wrote a treatise on it.

It consisted in preparing the part to be reconstructed and loosening a tongue of skin from some available portion of the arm or hand. After granulation was well established in both defects, the flap was brought into position by binding the member bearing it securely to the head. Owing to the length of time required for the granulations to appear, added to that for the healing process, and to the great inconvenience occasioned the patient, the proceeding was abandoned. In 1816, however, it was rescued from oblivion by Carl Ferdinand Graefe, who employed it in a modified form for blepharoplasty. Among other improvements, this surgeon hit upon that of putting the flap into place at once without waiting for the granulation of the surfaces to be united. The method has found scant favor in the eyes of modern surgeons, still less in those of their patients. In this country it has been resorted to with success by R. H. Derby[1] to replace the lids lost in an extensive burn of the face.

Still more recently it has been revived in France by Prof. Paul Berger,[2] the Parisian surgeon. In this admirable report, among much else of interest, Professor Berger details four cases in which he applied the Italian method to blepharoplasty. In three of them the reparation concerned the lower lid, and in the fourth both the upper and the lower. In the last case, death occurred from

[1] Trans. of the Am. Oph. Society, 1885, p. 141.
[2] Cong. fran. de Chir. séance du 9 otobre, 1889, 4 session, p. 361.

iodoform poisoning on the day previous to that which was set for the severing of the pedicle.

Mode of Operation (Berger).—An exact pattern of the lid defect is cut out of oil silk or court plaster, the arm is approached to the eye, and the point that makes the easiest and most natural contact is marked in ink, as the site of the pedicle. The pattern is then laid on in such a manner that the pedicle will be neither twisted, stretched, nor compressed, and so outlined that the area of the flap will be one-fourth to one-third greater than that of the model. The subcutaneous fat, as well as the superficial fascia, are included with the skin. Near the pedicle, the aponeurosis is slightly raised in order that the nourishing vessels may be free from pressure. All the wounded vessels of any size are tied.

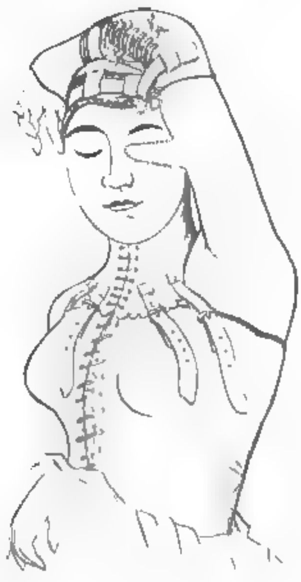


FIG. 192.

After many trials Berger adopted, as the fixing apparatus, a leather corset provided with a collar and cap, all articulated by laces and straps and strengthened by steel braces. A laced leather gauntlet, extending from the hand to a point above the elbow, put on and strapped to the cap, holds the arm firmly to the head (Fig. 192). Numerous fine, superficial, silk sutures are put in to hold the flap while, near the pedicle, a few, deep, strong ones are inserted to aid in resisting traction. Salol, boric acid, or iodoform powder (the last used guardedly) is dusted into the nooks and upon the other parts. Over this, gauze or a thin layer of cotton, wet with boric acid solution; on this, padding of cotton, and over all a bandage. Liquid food and constant watching by an attendant. Quiet in bed for four or five days, then propped up for a short time at intervals. After a week, sitting in an easy-chair, and even walking cautiously about the room. The pedicle is divided near the end of the second week.

In order to accustom the patient to the constrained posture and to the manner of performing such functions as sleep, alimentation, evacuations, etc., as well as to test the immobility of the parts concerned in the blepharoplasty, it is well to have him wear the apparatus for a few days before the operation.

CHAPTER VIII.

OPERATIONS UPON THE CONJUNCTIVA.

SYMBLEPHARON.

Literally, this term means an adhesion or a clinging together of the eyelids In its true sense, however, it refers to a union of the palpebral with the ocular conjunctiva, or to the severer condition wherein the lid is firmly adherent to the globe. Among the more frequent causes are burns from lime, molten metal, acids, etc. Owing to gravitation and to the exposed situation of the lower part of the conjunctival sac, it is more often affected than is the upper. The extent of the adherence varies from that of a tiny isolated bridge to that in which all traces of a cul-de-sac are lacking, and the entire inner aspect of the lid is united to the ball. Symblepharon is designated as *outward, inward, upward, and downward,* according to its location. For convenience in reference, the different grades are classified as follows:

1. **Symblepharon anterius,** commonly spoken of as *circumscribed,* is the simplest form, and is so named because the junction between the opposing portions of conjunctiva does not reach the fornix.

2. **Symblepharon Posterius, Partial Symblepharon.**—This class comprises the intermediate grades, or those in which the attachment extends to the fornix, but in which the cul-de-sac is not wholly obliterated, nor is there marked cicatrization of the bulbar conjunctiva.

3. **Symblepharon Totalis, Complete Symblepharon.**—Under this heading are included all the more pronounced cases where the attachment involves the whole of one or both lids, and the cul-de-sac is utterly effaced. In the exaggerated instances there is often ankyloblepharon also. Some authors (Fuchs among them) state that blindness, or at most, quantitative perception of light, is a necessary accompaniment of total symblepharon. This is by no means true of the commonest form, viz., that in which the entire lower lid is grown to the globe, even when, as often happens, the

conjunctival adhesion covers the greater portion of the cornea; nor is it invariably true of that in which both lids are attached throughout. Though in many instances sight has been restored only by the additional operation of iridectomy. Surgical intervention is a crying need in *all* cases, whether blindness exists or not. Among the objects sought are greater motility of lids and globe, better vision, relief from pain, improved appearance, and the making of a socket for the wearing of a prothesis.

The same principles are concerned in operations for symblepharon as in those for blepharoplasty, and the means are also similar, viz., by:

A. Sliding flaps of conjunctiva.
B. Pediceled flaps of conjunctiva or skin.
C. Mucous or cutaneous grafts.

A and B refer to autoplasty only; C to autoplasty, heteroplasty, and zooplasty. No intervention is admissible while contraction is still active in the adhesions.

1. The surgical treatment of the first group (symblepharon anterius) presents no special difficulties. It usually suffices, for the narrow bridges, merely to cut them with blunt scissors, or with a blunt bistoury and grooved director, and to watch for reattachments which, occurring, are at once broken loose with a probe. If the division of the symblepharon leaves a decided opening in the ocular conjunctiva, fine silk sutures are put in to close it. If a tag of the mucosa is left hanging to the lid, it is not severed until after the healing of the bulbar wound. If the bridge is fast to the cornea, the latter is first freed by careful dissection. In cases where the defect is so large as to cause undue stretching of the conjunctiva, in closing it Arlt advised the making of a bracket or relaxing incision on either side.

2. The handling of the second class of cases, or *partial symblepharon*, is, in the main, attended with great satisfaction, though they often call for much planning and perserverence. The easiest to deal with and the most frequently encountered is what is known as the *columnar* form, in which a thin, or relatively thin, bridle uniting the lid and globe reaches into the fornix and many times implicates the cornea. When it occupies the upper, lower, or outer

cul-de-sac, the operation usually adopted is that of v. Arlt.[1] Manner of doing it: If the conjunctiva is fast to the cornea, the so-called pterygoid symblepharon, the apex of the adhesion is held with delicate sharp-toothed forceps, and the dissection made with the bulge-edged scalpel. To aid in this step, some surgeons first put a suture through the apex to hold by. If this is done, the thread should be double-armed and so inserted as to make the loop lie crosswise, near the tip of the apex, and upon the outside, so that the same suture may be used at a later stage of the operation. As this means difficulty to avoid cutting the thread, it is better to dispense with the procedure.

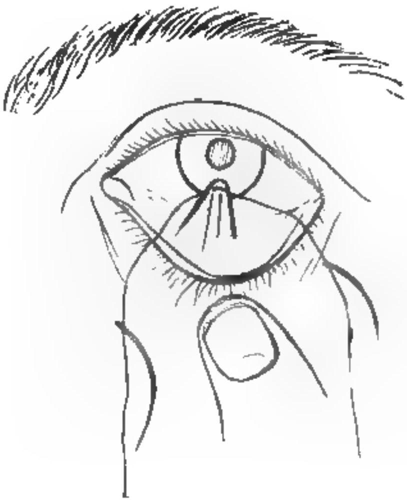


FIG. 193.—Arlt's operation.

Having passed the limbus, the dissection is carried on with small, blunt, curved scissors to the very bottom of the cul-de-sac—really farther, as a rule, than to the limits of the fornix. An incision is then made with straight blunt scissors, on either side of the bridle and close to it, from apex to base, if practicable, converging the two near their ends. If the double-armed suture has not already been put into apex as described, this is now done, the pocket at the base of the flap is pulled wide open, the needles inserted at its bottom, brought out through the skin, side by side, and tied over a cylinder of gauze. The edges of the

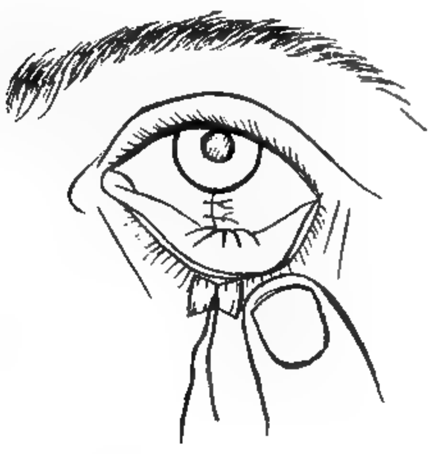


FIG. 194.—Arlt's operation.

[1] Graefe-Saemisch, Bd. iii, 1874, S. 439.

bulbar opening are undermined and united by fine silk sutures, the knots of which are not too tightly tied (Figs. 193 and 194).

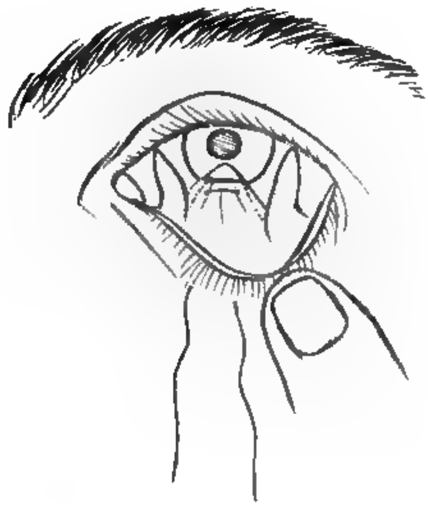


FIG. 195.—Teale-Knapp operation.

When the loosening of the lid from the eye leaves a defect too broad to be covered by simple lateral mobilization of the membrane, pedunculated flaps are fashioned from a part somewhat further away and turned in to fill the gap—a method first practised by Teale.[1] In detaching the symblepharon, if only its point involved the cornea, this surgeon made an incision across the growth, at the limbus, and left the corneal portion which was supposed to dwindle away from atrophy. The rest he separated in the usual way and (in downward symblepharon) took a vertical flap from either side of the cornea (Fig. 195); the two were disposed one above the other on the defect, to cover it, stitched together, and, also, to the cut edge of the pterygoid above, and to the lid flap below. The secondary defects were closed by simply drawing the conjunctiva together by sutures (Fig. 196). Teale,[2] at a later period, made an arched bridge flap from the lateral and upper conjunctiva which he slid down over the cornea, and stitched into

FIG. 196.—Teale-Knapp operation.

[1] Ophthalmic Hospital Reports, Oct., 1861.
[2] Report of Fourth Internat. Cong. of Oph., London, 1873, p. 143.

position, to fill the opening left by cutting away of a downward symblepharon.

Knapp[1] combines the method of Teale with that of Arlt. In downward attachment with corneal point, for example, he frees the cornea and separates the lid to its base, turns the flap thus formed down, and fixes it into the cul-de-sac by the double-armed, externally-tied suture of Arlt. He also arranges the flaps as did Teale and in order to keep them from riding up onto the corneal defect, sutures the lower one to the submucous tissue of the fornix.

In a case where the removal of a very large pterygoid symblepharon caused the loss of considerable of the corneal substance, Schrimer, to prevent a corresponding opacity, successfully grafted on to the place small lamellæ taken from the cornea of a rabbit.

Inward or outward symblepharon often affects both lids, and is attended by ankyloblepharon. As an example of surgical correction of inward symblepharon with ankylosis, the following method, after Langier (1860) and Arlt (1870), is cited. Supposing, as is frequently the case, there is obliteration of the internal fornices, and a broad band of skin unites the inner thirds of the lids. A horizontal incision is made, midway of the band, from its outer limit to the inner commissure; the symblepharons are detached, a double-armed suture is put into each of the resulting flaps, they are turned into their respective cul-de-sacs, and fixed by tying the threads over cylinders on the outer skin.

In the event of the primary injury having been deep in the fornix, it is best to excise as much as is expedient of the scar, for it is the inevitable pushing upward of this buried, inodular mass that is the undoing of many an otherwise excellent result. To prevent these relapses, Panas tried carrying the apex of the detached, downward symblepharon out through a slit made through the base of the lower lid, and suturing it to the cheek; but with poor success.

3. To attempt the relief of total symblepharon is always an arduous undertaking, and often a hopeless one. Baudry says of it, "*la cure de symblépharon reste-t-elle un des problèmes les plus difficiles de la chirurgie oculaire*," and Knapp speaks even more discouragingly, to wit, "The value of a symblepharon operation depends upon the extent of conjunctival surface that is preserved." He intimates

[1] Graefe's Arch. xiv, 1, 1868, p. 270.

that he believes with Arlt that cases of total atrophy (symblepharon) are, for the surgeon, a *noli me tangere*. And Fuchs flatly asserts that "cases of extensive symblepharon posterius and, obviously, those of symblepharon totalis, are incurable." It is a relief to know that the gloomiest of these gloomy views are not altogether warranted by the present status of the surgery in question and, as it has now been some years since the two last-mentioned eminent men expressed their opinions, it may be pretty safely assumed that they, too, have come to regard the matter in a more favorable light. That perfectly satisfactory results can be obtained in many of the most unpromising cases of total symblepharon has been, during the past ten years, positively and repeatedly demonstrated. It must be borne in mind, however, that a single operation will seldom suffice. The happiest issues have often come only after several interventions.

It were bootless to attempt the description of any considerable number of the myriad surgical measures that have been devised for the higher degrees of symblepharon, for the reason that the vast majority of them have availed nothing. It will serve better to call attention to a few that have proven more or less effective. The separating of the lid from the globe is usually a simple affair—to keep them separate is the perplexing thing. Obviously, this can be done only by interposing two leaves of tissue that will unite readily, one with the inner surface of the lid and the other with the corresponding surface of the globe, yet remaining distinct as regards their own opposing faces. To this end have been employed: (1) mucous grafts taken from the mouth, from the fellow eye, or that of another person, from the vagina, from the eyes of rabbits, hares, and dogs; (2) flaps of skin turned in from adjacent parts of the face, and (3) cutaneous grafts after the methods of Wolfe and Thiersch.

1. **Mucous grafts** undoubtedly afford the most suitable material with which to replace the lost conjunctiva, especially when the cornea is intact or, rather, when the eye is capable of useful vision. Epidermis is always irritating to the cornea. It may be from its harshness, from dryness, because of its oily surface, or from contained hairs, etc., and although its character does change in time so as to partake more of the nature of mucous membrane, it never entirely ceases to be dermic, and requires to be frequently cleansed

of dead epithelium. Moreover, mucous grafts are not only more suitable from a physiologic standpoint, better tolerated by the eye, etc., but they are more available since they may be furnished by the lower animals. Unhappily, they are, perhaps, the least fitting from a surgical standpoint. Not that they do not take promptly, but, for one reason, because of their exceeding frailty and tenderness, which renders them incapable of holding the retaining sutures.

The originator of this species of grafting was Wolfe,[1] of Glasgow, who in 1872 made use of the rabbit's conjunctiva. A little later (1873) Stellwag, of Vienna, experimented with the same, also with mucosa from the mouth and from the vagina. The rabbit's conjunctiva has been tried by hundreds since then, generally with some degree of immediate success, but the ultimate results have been uniformly disappointing. Thinking to profit by its greater toughness, Panas[2] essayed the effect of transplanting the conjunctiva of the dog—to no purpose. Just as with that of the rabbit and the mucosæ of man, there ensued a gradual pushing up, or shallowing of the cul-de-sac till at the end of a few months—nothing. After a day or two the epithelium comes off, and two granulating surfaces are found in contact, and neither the insertion of an artificial eye, a plate of metal, nor any known force will stop the relentless progress of the obliteration.

It is not improbable that some one will ere long hit upon the much-hoped-for method of permanently relieving symblepharon by the transplantation of mucous membrane. When this is found, it is likely that conjunctiva of some kind will be the mucosa selected, on account of its appropriate texture, the other kinds being far too meaty.

The method pursued has usually been, first, to detach the symblepharon completely, to copiously irrigate the cavity with salt or boric solution, stop all bleeding, and then cover the lids with a pad wet with the same solution. If the rabbit's conjunctiva is chosen, it is better to have ready two of them, in case of an accident to the first one used. The animal is chloroformed, its eye cleansed with the salt or boric solution, two or several sutures are put into the conjuctiva through small cuts, by which the area to be excised

[1] Annal. d'oct., t. 69, p. 121–126, 1873.
[2] Mal. des Yeux, t. ii, p. 181.

is marked off and by which also the piece is managed after detachment. If this is not done, it is next to impossible then to tell front from back. The lid to be repaired is pulled far away from the globe, the latter is rotated strongly upward (the operation being for a downward symblepharon), the borrowed piece, with or with out previous dipping in the warm solution, laid in right side out, the contained sutures fastened to the surrounding tissue, and as many others put in as are needed.

To finish, loop threads are put down through the middle of the graft, brought out on the cheek and tied over cylinders of gauze to form the cul-de-sac. Some operators wait for these to cut out. It is a good plan to lay on a piece of sterile oil silk or similar stuff before inserting the loop threads and pull it, folded, down with the graft, as recommended by Thilliez.[1] Or one could employ the paraffined lead plate, as detailed later. If a one-piece graft is not large enough, two may be joined together and handled as one, or one may be applied to the globe, the other to the lid and their lower edges stitched to the tissue at the bottom of the newly-made pocket. Where the rest of the bulbar conjunctiva is fairly normal, one may, as advised by de Wecker, combine the transplanting of Teale or Knapp (p. 324) with the mucous grafting.

2. **Pedunculated skin flaps,** under existing conditions, probably offer a greater measure of success than do mucous grafts, for the cure of total symblepharon, yet these, too, are far from reliable. A pioneer in their use for this purpose was Taylor.[2] He took the flap from the lower lid, in a case of downward symblepharon, with its base toward the nose. After loosening it up, he cut a vertical slit through muscle fascia and conjunctiva, near the pedicle of the flap, pushed the latter through, twisted it 180° on its long axis and stitched it to the inner side of the lid with its epidermis next to the globe. The outer defect was then closed by sutures. Chisolm[3] made the same operation, except that the pedicle was left at the temporal side.

Harlan[4] for a case of total lower symblepharon, formed a bridge flap (with relatively narrow pedicle at either end) on the cheek

[1] Jour. des Sc. med. de Lille, 1898, p. 143.
[2] Med. Times and Gaz., i, July, 1876, p. 4.
[3] Virginia Med. Monthly, 1877, p. 180.
[4] Trans. Am. Oph. Society, 1890.

below the lid, cut through into the bottom of the newly prepared fornix along the upper edge of the flap, pushed the latter through the opening, twisted the pedicles to bring what had been the lower edge on a level with the free border, and stitched it in place with its epithelium facing the eyeball. The result was only a partial success.

Panas[1] in a similar case cut a flap from the temple and one from the cheek, carried them through a buttonhole in the outer orbito-palpebral furrow, applying one to the lid and the other to the globe, their cuticular surfaces in contact. After they had become firmly adherent, their pedicles were cut and the buttonhole closed. For total symblepharon of both lids, the same surgeon took a large flap, the shape of a tennis racket, from the temple, pedicle near the orbit, turned it in through the palpebral fissure, and put the raw side in apposition with the two freshly dissected tarsi. At the end of three months the flap was bisected horizontally, to reestablish the opening between the lids. The operation was undertaken to enable the patient to wear an artificial eye, the cornea having been destroyed by sulphuric acid, but the object was not attained.

In a case of double total symblepharon, in which heteroplastic and other autoplastic procedures had been tried in vain, Samelsohn[2] succeeded in the manner following: from the skin of one lid he borrowed a quadrilateral flap, which was left attached along the ciliary border, and turned it into the palpebral fissure to line the posterior surface of the opposite lid. Union having been established, the flap was severed at its base and the measure was repeated, from the other side, for the fellow lid. The principal cause of failure in most of these flap operations has doubtless been neglect to construct a capacious artificial cul-de-sac and to provide means for its preservation. Panas, with his two flaps for the restoration of the lower fornix, fulfilled the first condition, but not the second. To cover only one side of the raw pocket made by separating the lid is clearly a lame procedure.

The most formidable foe to be combated in this surgery, is the progressive ankylosis between lid and globe, which tends to efface one's work. As a support for the transplanted tissue—to keep it in place—in coaptation with the surface it is to unite with, and to

[1] Mal. des Yeux, T. ii, p. 182.
[2] Heidelberg Congress Report, 1892, p. 149.

mold the cul-de-sacs—glass or porcelain eye shells have long been employed. The trustiest weapon for the purpose would seem to be a properly fashioned plate of soft metal, as described, along with other means to the same end, in the next section.

With a view to the prevention of a relapse, Scott[1] everted the lid, put it on the stretch, and fixed its free border to the skin with the aid of fine silver sutures, keeping the eye occluded until the transplanted tissue took.

3. **Cutaneous Grafts.**—The transplantation of skin by the Le Fort-Wolfe method, to replace lost substance in the surgical treatment of symblepharon has, like that with mucous grafts, proven of little value. Their great thickness, and the excessive degeneration and shrinkage which they usually undergo, having necessitated their abandonment. Of late years their use has been confined mainly to the restoration of the cul-de-sacs in cases where the globe was absent. C. H. May,[2] of New York, has reported the successful "transplantation of a large *Wolff* (Wolfe) graft, forming a new lining for the *orbit* and permitting the wearing of an artificial eye." The graft was wrapped around a porcelain support and the whole, placed in the new-made socket, where a few fine sutures united the edges of the piece with those of the conjunctiva.

Epidermic grafts, on the other hand, afford the best known means of repair for the defect under consideration. They were used, to a limited extent, in symblepharon operations by v. Arlt, in small patches upon a granulating surface, after the manner of Reverdin. Later, more extensively and in broader pieces, by Eversbusch[3] and many others.

Czermak[4] gives an ingenious procedure for total symblepharon of the lower lid, founded on a method of epidermization by Eversbusch. The palpebral fissure is extended to the outer rim of the orbit by a horizontal incision with the scalpel. From the outer extremity of this another is made, down and in, along the orbito-palpebral furrow, till it reaches a point one and one-half centimeters below the inner canthus. The incision is deep enough to include the whole thickness of the lower lid, which latter is dissected up in

[1] Lancet, July 31, 1897.
[2] Arch. of Oph., vol. xxx, No. 5, 1901.
[3] Münch. med. Wochschr., 1887, Nr. 1 u. 2.
[4] Aug. Operationen, 1893, p. 309.

the form of a flap with its pedicle inward. The flap or lid is then turned back over the nose, the bleeding is stopped, and the raw surface of the globe and orbital contents covered over with a Thiersch graft. The entire area is dusted over with iodoform powder and covered with a piece of tin-foil, or gutta-percha tissue, well smeared on both sides with vaselin. This covering must extend beyond the outer and under borders of the wound and be pushed snugly into the angle at the base of the flap. Above it must overlap the cornea. If the latter is transparent, gutta-percha tissue is chosen instead of foil. The graft is made to cover the lower half of the cornea also. Now another epidermis graft, correspondingly large, is laid on the tissue (or foil), epithelium downward, and the flap is turned back into place. Both lids are now covered with a piece of gutta tissue greased with vaselin, and, over all, the regulation cotton pad and roller bandage. The foil or tissue keeps the two grafts apart while they heal. As soon as they have become firmly adherent, with configuration like that of the flap, an incision is made along the margin of the posterior defect, that must run exactly as did the one by which the flap was originally outlined. In this way a cut is made that, by the contraction of the surrounding tissue, is seen slightly to gape. Then the whole convex edge of the flap and that part of the upper edge near the point, made by the first or horizontal cut, is freshened with the scissors and sutured to the surrounding skin. Thus is formed a deep cul-de-sac. A linear scar remains, of course, and the lower lid looks puffy, "but faults like these," says Czermak, "are not to be taken into account in such desperate cases." He considers the operation of special utility in making a new socket for holding a glass eye.

But it is in the United States that the employment of epidermic grafts in this connection has been attended with the highest degree of definite success. Hotz[1] advocated the use of Thiersch grafts to replace the destruction of conjunctiva in extensive symblepharon. Among the first signal triumphs in this country was one at the hands of C. H. May[2] (in May, 1897) of New York. There was total symblepharon of both lids. A number of large epidermic grafts were used which were kept in place by a porcelain shell resembling

[1] Annals of Oph., April, 1893.
[2] Reported in the Archives of Oph., April, 1899.

an artificial eye. The result was perfect. Four years after the operation it was still so. In April, 1899, the same surgeon,[1] after vain attempts to relieve an extensive lower symblepharon by older methods, detached it freely and placed a large Thiersch graft over the defect thus made. This, too, was kept in place by means of the porcelain shell. The cornea was transparent over two-thirds of its area, yet the shell was well tolerated. In addition, the graft was stitched to the margins of the raw surfaces by delicate sutures. The graft adhered promptly and the symblepharon was cured. Fifteen months afterward the effect of the operation had not diminished. In July and August, 1899, by two successive operations, Hotz[2] relieved a nearly complete symblepharon of the upper lid, covering the raw surfaces, after dissection, with broad Thiersch grafts. Knowing of May's use of the porcelain shell to hold the graft in place and having no such shells at his disposal, he "cut from a thin sheet of lead an oval disk large enough that when slipped under the lids it would fill the whole space from the retrotarsal sulcus of the upper lid to that of the lower lid, and shaped and molded it so as to fit accurately the curvature of the ball. A Thiersch graft, taken from the arm, was spread out smoothly over the plate, epidermis toward the lead, in such a manner that it covered the upper two-thirds of both sides of the plate. Thus mounted, the plate was inserted under the lids as we insert an artificial eye. The lid borders were united by three sutures." The eye was dressed, and lid sutures removed on the fourth day. Although the graft was adherent throughout, the plate was worn four days longer.

The second operation was for the purpose of piecing out with a Thiersch graft a small area that the first one failed to cover. The eye was sightless and the operation was to make a prothesis practicable. Dr. Hotz has just informed me that the patient is wearing the glass eye with perfect comfort at the present time (March, 1906). In November, 1901, Hotz[3] presented at a meeting of the Chicago Medical Society a case wherein he had cured almost total lower symblepharon in a similar manner. Instead of the large plate, filling the entire conjunctival sac, as in the first case, he used one the size and shape of the inner aspect of the lower lid, with four small

[1] Reported in Arch. of Oph., vol. xxx, No. 5, 1901.
[2] Oph. Record, Nov., 1899.
[3] Chicago Med. Recorder, Dec., 1901.

holes through it near the upper edge. The plate was covered with the graft, put into the new cul-de-sac and fastened along the free border by silk sutures passed through the perforations and through the lid. Two supplementary operations were required to complete the cure in both of these; the lead plate also was used, but the suturing together of the lids was omitted. Fifteen months after the first operation and three after the last the lid was free, easily evertible, and there was perfect motility of the eyeball. In this case, the greater part of the cornea was transparent—had escaped injury—and the sight was preserved.

At a meeting of the Ophthalmic Section of the Philadelphia Medical Society, April 17, 1900, Oliver reported a case of complete restoration of the conjunctival sac by a single epidermic graft. Indeed, since the publication of Hotz's and May's first articles on the subject such operations have been made by ophthalmic surgeons all over the land and, in numerous instances, with most gratifying results. A notable series of six cases was reported and exhibited by H. W. Woodruff[1] at the meeting of the Chicago Ophthalmologic Society, February 10, 1903. Three had been relieved of high-grade or total symblepharon and three, where the globe had been enucleated and the cul-de-sacs had been effaced, were furnished with new sockets. Woodruff thus describes his mode of procedure:

"The patient should be under a general anesthetic, preferably chloroform. The eyebrow and skin about the eye, and the surface from which the graft is to be taken should have been previously thoroughly cleansed with green soap and hot water, washed with alcohol, and bandaged. Immediately before the operation is begun the field is freely flushed with boric acid solution. If a pseudopterygium is present, it is first dissected from the cornea, and the lid is thoroughly freed from its attachment to the eyeball, and the cul-de-sac must be made large in all dimensions. Cicatricial bands should be removed entirely. Bleeding is checked by hot water. A plate is now cut from a sheet of block tin, which will snugly fit into the new-formed cul-de-sac. The corners are rounded off and the edges smoothed with the scissors or file. If the case be one of symblepharon, and there is danger of the plates rubbing on the cornea, it may be cut out in the center to the extent required. Four

[1] Annals of Oph., March, 1903.

holes are made for the sutures, two at the outer and two at the inner angle of the plate, to correspond to the lid margin. A razor which is known to be in good condition is used for removing a thin layer of skin, about one-third wider and more than three times as long as the plate. In the method known as Thiersch's the transplanted flap includes only the epidermis and superficial layer of the dermis. The graft is best taken from the inner surface of the arm, which is put on the stretch by firm pressure with the hand, and made flat by pressure with the razor while cutting. The graft is transferred at once to the plate, and folded over it with the raw surfaces external. Plate and graft are then pushed into the cul-de-sac, and sutured to the lid near its margin, tying them over small rolls of gauze. The lids may be sewed together and dressed with gauze, and bandaged in the usual way. Both eyes should be bandaged as long as the plate is in place, and absolute quiet maintained. The plate is removed in four days, and more freedom allowed the patient."

This is essentially the method as generally employed in America. It will be observed that Woodruff speaks of having used plates of block tin. This is probably a cleaner metal for the purpose than is lead, less affected by the secretions of the eye and the fluids in the raw tissues, though in other respects there is no choice between them. Woodruff continues, "The particular advantages claimed for the use of the plate over any other method of skin grafting are:

"1. It enables one to place the graft at once in the position wanted.

"2. It holds it down in the very bottom of the artificial cul-de-sac until it has adhered, so that the raw surfaces of the lid and ball in no part can again unite with each other in this angle, and, even when the graft lives, gradually push it upward, as, in my experience, it does, unless the plate is used.

"3. We secure, with the plate, accurate approximation over the whole extent of the graft, and rest."

Weeks, of New York, at the Congress of Ophthalmology, Lucerne, 1904, gave a method for the restoration of the conjunctival cul-de-sacs that he declared to have been highly successful in cases of anophthalmos with obliteration of the socket. He believed that the procedure owed its efficacy solely to the fact that a fixed point of attachment was found for the graft in the periosteum at the rim

of the orbit. In addition, however, he had made use of a plate for the support of the transplant. In this instance the plate is gutta-percha, such as is employed by the dentists under the name of "base-plate." A piece of this is cut to the desired outline, molded to shape after immersion in hot water, and its form definitely fixed by putting it in cold water. The first step of the method is the making of a free canthotomy, in order to obtain room to operate. Only one fornix is restored at a time. The lid is detached almost to the margin of the orbit, and the cavity packed with cotton wet with normal salt solution. A Wolfe graft is rapidly cut from the arm, freed from subcutaneous tissue and dipped in the warm salt water. It is then folded, epithelium inward, and three double-armed sutures passed through at the bottom of the crease, leaving loops, two millimeters long, on the cutaneous surface. The sutures are next put through the periosteum of the orbital rim, from the bottom of the newly formed cul-de-sacs, and out on the cheek. The graft is helped into place while the sutures are all drawn down, and threads are tied over rolls of iodoform gauze. Small interrupted sutures fasten the graft to the conjunctiva of the lid and to that of the ocular stump. Now the plate is inserted and, lastly, the stitches put in to close the canthotomy. The deep sutures are left in for ten to fourteen days, those in the conjunctiva are removed in one week. The plate is left *in situ* until all shrinkage ceases in the flap.

The writer, having found the gutta-percha plate unsatisfactory, went back to the lead. With it the periosteal sutures are a superfluous complication. A valuable expedient is that of Wilder, of Chicago, whereby the leaden shell is coated with paraffin. By holding the plate with forceps by its middle, and dipping it several times in liquid paraffin of high melting-point, the surface and edges are made absolutely smooth and non-irritating. Another good suggestion of Wilder's is that, instead of making a number of small holes in the plate for the passage of the sutures, two large openings are made, one on either side of the center. These serve just as well for the threads, besides affording much-needed facilities for drainage and cleansing. The tip of an eye-dropper can be inserted at one opening and the injected fluid escape at the other. In conjunction with a Thiersch graft suturing to the conjunctiva is unnecessary.

Though it is wise to fix the graft to the plate by a few turns of thread in order to prevent it from slipping while being put into the socket.

Upper, outer, and lower cul-de-sacs can all be restored by a single operation. Indeed, there is every good reason for doing whatever is needed all at one sitting, and none against it. If need be, the entire plate may be covered by the graft. In any case it is better to have a superfluity than a lack of tissue on the metal.

Since writing most of the foregoing I have had the good fortune to restore perfectly the cul-de-sacs in a few cases of total symblepharon where the eye was present, and to make artificial sockets that are entirely practical and satisfactory for the wearing of a prothesis in a number of others where enucleation had been performed and there had been complete obliteration of the conjunctival sac. In the first category the lead or block-tin plate, with and without the paraffin coating, has been employed, and with and without the opening for the cornea. In the second class, i.e., those in which the bulbus had been removed, plates of the same materials have been used with or without perforations for drainage and cleansing. Of the two metals, lead or block-tin, for the plate I prefer the last as being least affected by the fluids normally or artificially present in the eye. The great advantages of such plates are that they can be readily fashioned of any shape and size by means of the fingers and strong scissors, and perforations of suitable dimensions are easily made in them. Moreover, they can be bent by the fingers into forms similar to that of an ordinary artificial eye. In order, however, to make them evenly concavo-convex so that there will be no signs of crimping or ruffling around the edges, a more elaborate handling would be necessary. Fortunately, precision so great is not required. When it is to be fitted over the eyeball the thickness of the plate need not exceed one thrity-second of an inch, especially if the paraffin coating is put on. But when the newly formed cul-de-sac is intended for receiving and holding a prothesis, particularly one of the Snellen kind, or "reform eye," it should not only be deep and long, but extra wide as well, so that, in the process of cicatrization, it will still remain of fair capacity. Here, then, a thickness nearer one-sixteenth of an inch were better. This, heavily coated with paraffin, will make a plate that very closely

resembles a glass eye—especially at and near the outer border. In lieu of a sheet of metal of sufficient thickness I have fastened two pieces together with collodion. At least one perforation in the plate may be regarded as an absolute necessity. If the globe be intact, a large opening corresponding in size to that of the cornea serves to obviate undue pressure and friction upon this sensitive membrane. It also permits of inspection, so that one may be informed as to the health of the cornea and as to whether or not the posterior leaf of the graft is "taking" within the limbus. Besides it gives opportunity for irrigation. Where the eye is absent there may be one or two perforations. Should the graft required be large enough to cover the entire plate, as is true in operations for restoration of all four cul-de-sacs, there is only room for one opening 3/16 to 1/4 inch in diameter in the center; or for two, each about 1/8 inch, placed close together on the horizontal axis of the plate. Either will serve for cleansing the cavity or for manipulating the plate. If the openings are larger they deprive the graft of the support it needs. A squint-hook, put in through one of these perforations, acts well as a handle by which the plate may be mobilized and withdrawn when the proper time arrives. In coating a one-hole plate with paraffin a pair of fixation forceps may be thrust through the opening, when the "spread" of the instrument will suffice to hold the plate. If there are two holes one prong of the forceps is passed through each.

Apropos of the paraffin coating, it would seem to be of unquestionable value. As Wilder has pointed out, the advantages of a plate so prepared over the naked metal are greater smoothness, less harshness, and the very desirable qualities, in addition, of causing the epithelial surface of the graft to lie evenly spread out, or clinging, and the facility with which it may be built up into appropriate form and thickness. Wilder says that the melting-point of the paraffin should not be lower than 130° F. I would recommend that it be as high as it is possible to obtain it; for I have observed that there is a tendency of the surface to become hummocky and for a ridge to form along the palpebral fissure after the plate has been in the eye for a few days. The harder the substance, of course, the more uniform the coating would remain under the influence of the animal heat and the movement of the

tissues. That the new cul-de-sacs must be fashioned and maintained on a generous scale cannot be too strongly insisted upon. Extra free division of the tissues at the outer canthus is the first essential step. This is nicely sutured as soon as the plate is put in place. The plate, if of adequate size, will be too large in some instances to be removed without making a second canthotomy, which also should be followed immediately by suturing. After this a somewhat smaller plate may be substituted, or, if the original one has again been inserted, it may be cut in two with strong scissors, *in situ*, before removal.

It has for some time been a cherished intention on the part of the writer to procure a number of ordinary shell eyes of varying sizes, and to have made in them suitable openings. These are to be coated with the paraffin and used instead of the lead plates. I fancy they would possess distinct advantages over the metal plates in all save the doubtful one of allowing themselves to be cut in two while in position.

More recently we have taken the graft directly from the razor and placed it on the plate, i.e:, without dipping it in the salt solution; nor have any sutures been employed in holding the graft to the plate.

PTERYGIUM.

Pterygium, also called pterygion, is from the Greek, meaning, literally, *little wing*, and in German it is Flügelfell, or *wing film*. The term is used in the various branches of zoology to denote certain fins of fishes, feathers of birds, and coverplates of insects. In pathological anatomy the word, besides its more common application here under discussion, is also employed with reference to a growth of skin over the nails. Indeed, ocular pterygium was, by Celsus, called *unguis*. As applied to the eye, the word signifies a growth of thickened or otherwise changed conjunctiva encroaching more or less upon the cornea. Two varieties are recognized, viz., the true and the false.

True pterygium is always situated in the horizontal meridian of the eye and is usually the result of prolonged irritation of that part of the conjunctiva exposed through the palpebral fissure, by

wind, dust, etc., hence rarely occurring in females. It appears as a triangular band of more or less reddened conjunctiva with its apex primarily at the limbus, and may be either stationary or progressive. It is most often situated on the nasal side of the cornea (internal pterygium), less often on the temporal (external pterygium) and still less often on both sides at once (double pterygium). Its rounded, whitish apex is usually referred to as the *head*, the adjoining portion as the *neck*, and its wide, fan-like expansion as the body.

Another classification is made of true pterygium into *progressive* and *stationary*. The former being characterized by greater vascularity, redness, and thickness (pterygium crassum), while the latter is pale and thin (pterygium tenuis). Originally, of course, the second form has been of the progressive kind which has become retrogressive.

Progressive pterygia demand operative interference at the earliest possible moment, in order to insure good and lasting results. In proportion as they are allowed to occupy the pupillary area of the cornea, the sight is prejudiced, both immediately and consecutively.

The stationary variety, especially when the cornea is but slightly implicated, may be safely let alone. It is eminently justifiable, however, that they be removed, if only for cosmetic reasons.

The number of operative procedures that have been devised for the cure of the growth in question is very large, but for convenience, the methods may be reduced to three or, at most, four.

1. Ablation, or the complete taking away by excision, or by the latter combined with scraping and cauterization, called also abscission.

2. Transplantation—called by some *deviation*, and by others *burying*.

3. Ligation.

4. Cauterization (though hardly admissible except as an ad junct to one of the other measures).

1. Operations for pterygium were resorted to in very early times. The growth was looked upon as a species of tumor, of a certain malignance, and it was dealt with by ablation, partial or complete. Celsus,[1] for example, seized the neck with a sharp hook and passed

[1] Rome, A. D. 1.

through it a thread, to which he held with one hand while, by means of a small knife, he detached the neck and body, severed the base, and allowed the wound to heal by granulation. If at the nasal side, he was careful to spare the caruncle, as to remove this body, he believed, would cause epiphora.

Ætius and Paulus,[1] of Ægina, also made ablation of the pterygium, but instead of using a knife, they detached it from base to apex, with the aid of a horsehair passed beneath, which they worked like a saw. According to Richter,[2] however, these surgeons left the head behind, and Acrel was the first to dissect off this part. Richter himself and Scarpa,[3] extirpated the corneal portion only. The idea of closing the defect left after ablation of the pterygium first occurred to Coccius.[4] Previously, the diverging lines of the pterygium were followed in the extirpation, a large trapezoid scleral defect was left to heal as best it might, in consequence of which, not only did there remain a large area of cicatricial tissue, which interfered with the action of the underlying rectus muscle, but was, moreover, unseemly in appearance, and often leading, through overgrowth of granulation tissue, to what was called "secondary pterygium."

To obviate this, v. Arlt[5] in cases of large pterygia, instead of following the borders of the scleral portion, made two converging incisions which, meeting at or near the caruncle, left only a relatively narrow, triangular, scleral wound opening. The piece excised, or, if you will, the whole bared space, was manifestly of rhomboid or diamond shape, its greatest measurement being horizontal. Later, following Coccius, he undermined the edges and brought them together by fine sutures. When the growth was of small dimensions Arlt often contented himself by merely dissecting off little more than the corneal part, leaving the scleral division, in front of which he sutured together the conjunctiva, to disappear spontaneously.

If the abandoned growth became swollen, or if it in any way inconvenienced, it was excised by a simple snip of the scissors. A.

[1] Greece, A. D. 7.
[2] Treatise on Surgery, Göttingen, 1771, p. 92.
[3] Trait. des malad. des yeux, 1802–1816.
[4] Ruete, Lehrb. der Augenh., 1854, Bd. ii, S. 267.
[5] Die Krankheiten des Auges, i, S. 164. Prag., 1850.

Pagenstecher, of Wiesbaden, adopted this method. Arlt's method of ablation, but slightly modified, still constitutes one of the favorite and most effective pterygium operations, when the growth is of moderate size and, as performed by the author, may be described as follows:

The eye is cleansed and put under local anesthesia. The lids are held apart by the blepharostat. The entire width of the growth, about at the junction of the neck and body, is caught up by strong mouse-tooth forceps, where an opening is made through beneath it with knife or scissors. If it is loosely attached to the cornea, one may now avail one's self of the admirable method of *divulsion* invented by Prince, of Springfield, Ill. This consists in passing a Prince divulsor or a flat strabismus hook or other similar instrument through the opening and forcing it toward the apex with a series of short, prying motions, as a river of staves uses his frow. In this way one often has the satisfaction of seeing the cornea stripped absolutely clean. If the growth is too firmly adherent to yield readily to this maneuver, a keen, narrow bistoury, or small scalpel, is used. It is worked from the limbus of the cornea toward the center, first loosening the lower edge, then the upper, then between the two, always hugging the cornea.

It is well before loosening the apex to finish the incisions that outline the diamond to be excised, as they can then be placed with greater precision. These, made only with small, straight, blunt scissors, extend, divergent, for a short distance from the limbus, governed by the size of the pterygium, then convergent to meet at or near the caruncle or the neighboring canthus (Fig. 197).

We may now try to rive off the head or tip by prying. If this fails, the knife is passed entirely beneath and this portion is severed by a light sawing movement. To begin the dissection at the head, except in the event of the pterygium being a cicatricial or an unusually meaty one, is unsurgical. Finally the excision of the scleral part is finished with the scissors, taking care to avoid the sheath and tendon of the rectus. Any corneal remains of the growth are scraped away with a convex scalpel, or sharp curet, and the episcleral tissue in the immediate vicinity of the limbus is likewise got rid of. To prevent overlapping the cornea, two vertical incisions are now made in the conjunctiva, one upward and the

other downward, for a few millimeters from the base of the denuded space on the cornea, the edges of the scleral wound are undermined for some distance by means of the blunt scissors and brought lightly together by very fine silk sutures (Fig. 198). These have been recently boiled in vaselin-paraffin. One should see to it that each bite of the thread is deep enough to hold firmly.

A carefully applied four-yard wet netting roller is put on, the patient is told to keep very quiet for forty-eight hours, and to refrain from use of the uncovered eye, also to keep it mostly closed.

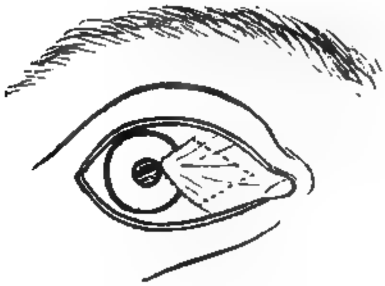


FIG. 197.—Arlt

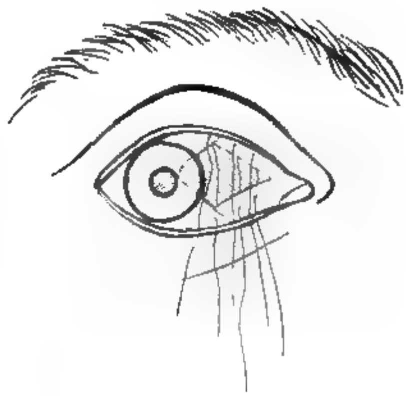


FIG. 198.

At the end of this time occurs the first inspection and redressing. After this, daily for a few times. The sutures are taken out three or four days from the date of operation.

2. **Transplantation** of pterygium, in order to divert its growth from the cornea, was originally conceived by the elder Desmarres.[1] This surgeon dissected up the growth like a flap, from its base to its apex, then from a convenient point on the lower edge of the conjunctival opening he carried an incision, parallel with the corneal margin, sufficiently far to accommodate the loosened pterygium. Into this, after having been opened into a triangular bared space, he turned the growth and secured it there by sutures (Figs. 199 and 200). The defect remaining about the limbus was left to heal by granulation. When the apex of the pterygium is truncated the

[1] Traité théorique et pratique des maladies des yeux, 2e édition, 1855, Paris, t. II, p. 168.

younger Desmarres[1] advises dividing it into two equal portions by a horizontal incision, and transplanting the two halves into two conjunctival notches, one above and the other below.

Knapp,[2] in order to adapt the Desmarres double transplantation

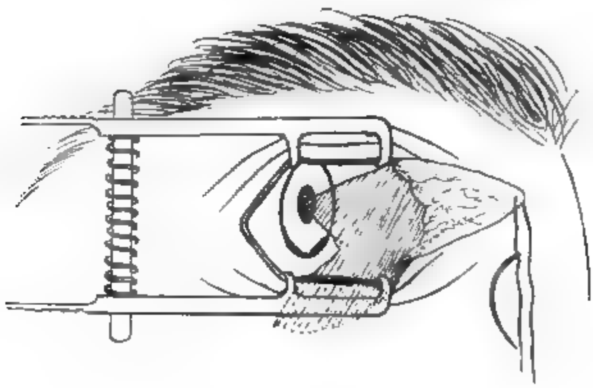


FIG. 199.—Desmarres, No. 1

method to the larger pterygia, modified the procedure in certain important respects, the technic of which, as described by him in Norris and Oliver's System, p. 837, is essentially thus:

The body of the pterygium is seized with fixation forceps and detached with a narrow cataract knife from near the limbus to and

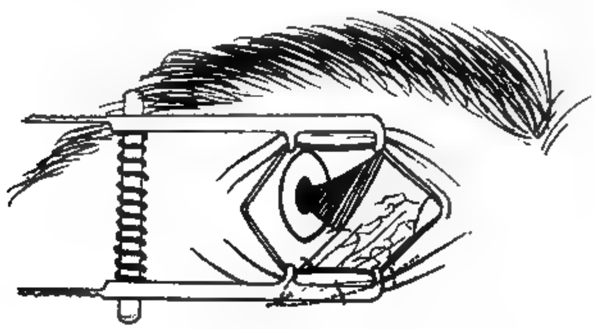


FIG. 200.—Desmarres, No. 2.

including apex, boldly cutting through the epicorneal tissue so as to leave nothing of the growth behind. The scleral portion is incised along its upper and lower borders and the cuts prolonged in

[1] Leçons cliniques sur la chirurgie oculaire, Paris, 1874, page 302

[2] Archiv ur Ophthalmologie, Bd. xiv, I Abtheil, 1868, S. 267.

a curved direction into the upper and lower fornices. The whole is then loosened from the eye in the form of a triangular flap which is split horizontally into two equal portions. The part representing the gray infiltrated head is cut off. The tip of each half is stitched into the corresponding angle formed by the upward and downward prolongations into the fornices. To cover the remaining defect, two vertical incisions are made in the conjunctiva, beginning at the limbus, extending up and down for several millimeters, getting further from the cornea as they advance. Thus two squarish

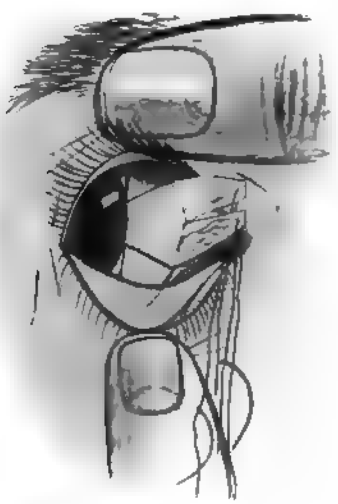


FIG. 201.—Desmarres, jr. Knapp.

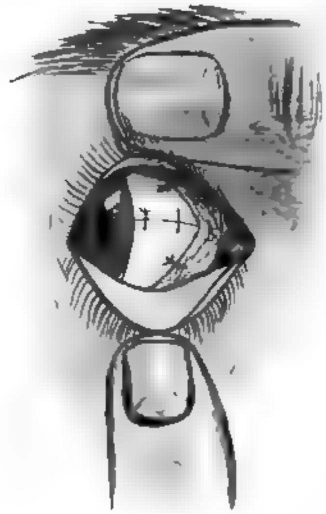


FIG. 202. Desmarres, jr. Knapp.

flaps are outlined which are undermined and joined together by two sutures. The better to fix the various flaps and to keep them from overriding the cornea, the suture furthest from the cornea is made to include the conjunctiva at the apex of the angle between the two halves of the divided pterygium (Figs. 201 and 202).

Both eyes are bandaged for twenty-four hours—afterward only the operated eye—though the patient is advised to use the uncovered eye as little as possible the first week. The threads are removed in five or six days. Both this and Desmarres' are true transplantation operations.

McReynolds,[1] of Dallas, has, by a most ingenious and effective modification of the original Desmarres operation, given new impetus to the transplantation method in this country. The present writer is among the many who can testify, from experience with a number of cases, to the excellence of the procedure. The different steps of the operation, as described by its author, are as follows:

1. Grasp the neck with strong narrow forceps.

2. Pass a Graefe knife through the constriction and as close as possible to the globe; then, with the cutting edge turned toward the cornea, shave the growth smoothly from that membrane.

3. With the fixation forceps still hold the pterygium and with slender straight scissors divide the conjunctiva and the subconjunctival tissue along the lower margin of the pterygium, commencing at the neck and extending to the canthus, a distance of 1/4 to 1/2 inch.

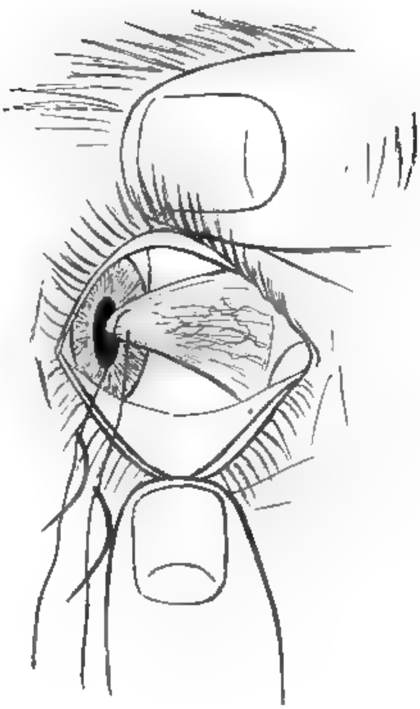


FIG 203.—McReynold's modification of Desmarres', Sr.

4. Still hold the pterygium with the forceps and separate the body of the growth from the sclera with any small, non-cutting instrument. (A flat Graefe strabismus hook serves admirably.)

5. Now separate well from the sclera the conjunctiva lying below the oblique incision made with the scissors.

6. Take black silk thread, armed at each end with smallest curved needles and carry both of these needles through the apex of the pterygium from within outward. Separate one from the other by sufficient amount of the growth to secure a firm hold (Fig. 203).

[1] Journal of the American Medical Association, Aug 9, 1902.

7. Then carry these needles downward beneath the loosened conjunctiva lying below the oblique incision made by the scissors. The needles after passing in parallel directions beneath the loosened lower segment of the conjunctiva, until they reach the region of the lower fornix, should then emerge from beneath the conjunctiva at a distance of about 1/8 to 1/4 inch from each other.

FIG. 204.—McReynold's modification of Desmarres, Sr.

8. With the forceps lift up the loosened segment of conjunctiva and gently exert traction upon the free ends of thread, which have emerged from below, and the pterygium will glide beneath the loosened lower segment of conjunctiva, and the threads may then be tightened and tied, while the surplus portions of thread are cut off, leaving enough to facilitate the removal of the threads after proper union has occurred (Fig. 204). It is very important that no incision be made along the upper border of the pterygium, because it would gap and leave a denuded space when downward traction is made upon the pterygium.

If the head of the pterygium is very large, it is cut off before the pterygium is drawn down beneath the loosened segment of conjunctiva. If any overlapping of the cornea occurs, McReynolds simply trims away the offending portion of conjunctiva. This is more a *burying* than a *transplanting* of the pterygium.

The writer would urge, as a precautionary act of no little importance, that before proceeding to draw the pterygium down into the prepared pocket, the blepharostat (or retractor) be removed. The effect of this instrument is, by its pushing the conjunctiva up

into the fornix, to greatly limit the extent to which that membrane can be drawn down. This is particularly necessary in cases of elderly subjects and in those afflicted with chronic inflammations of the conjunctiva, and whose cul-de-sacs are, in a measure, obliterated from atrophy. It is also highly advisable, before actually putting the growth in its new place beneath the conjunctiva, to take it by its head with the forceps, pull it down and note and mark the place where it fits best.

The younger Desmarres,[1] for large pterygia with truncated apices, divided them in two and transplanted similar to Knapp, but, like Desmarres the elder, he left the scleral defect uncovered.

Galezowski,[2] after mobilizing the pterygium, put a double-armed suture through the apex, tucked the growth back beneath the semilunar fold, or the caruncle, where he brought the suture out and tied it.

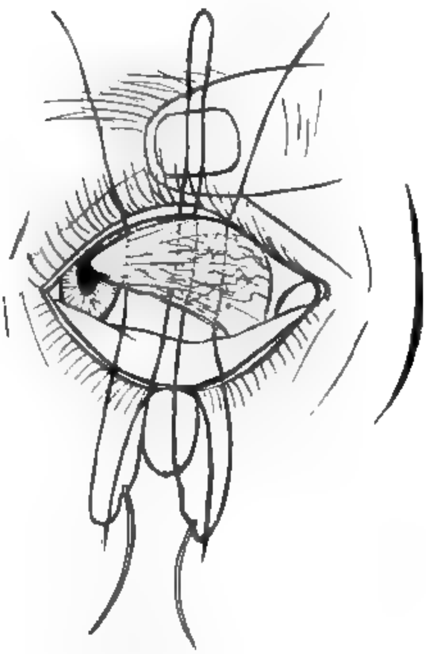


FIG 205. Szokalski's ligature.

3. **Ligation.**—In connection with the surgery of pterygium, this measure, though still occasionally resorted to, may be considered obsolete. Its origin is associated with the name of Szokalski.[3] This operator passed two curved needles beneath the pterygium, one near the apex, the other near the base, both being attached to the same thread (Fig. 205). The thread was then cut close to the needles. In this manner three ligatures were made, two single and one (the middle) double. The single ones were tightly knotted. The third, formed by the loop of thread, served to detach and lift up the pterygium. At the last this thread

[1] Leçons cliniques sur la chirurgie oculaire, Paris, 1874, p. 302
[2] Maladies des yeux, 1888.
[3] Roser u Wunderlich Archiv., 1845, Nr. 2.

was made into a slip-loop around the pterygium and the ends fastened to the cheek by means of collodion. After a few days the growth perished and was excised.

Von Arlt,[1] in a case of cicatricial pterygium, following blenorrheic conjunctivitis, cast two ligatures around it and allowed them to cut through. The pterygium soon after disappeared.

4. **The thermal cautery** as a single measure for the removal of pterygium, though it has been, to a limited extent, used in this capacity, is not especially to be commended. Its only place, in this connection, would seem to be in conjunction with other means more strictly surgical. For example, Martin,[2] of Bordeaux, after having practised ablation of the growth, made several successive cauteries on the site of the corneal implantation, by means of a strabismus hook heated to redness in the flame of a spirit lamp. Panas[3] did the same, only with an olive-tipped thermocautery. Chibret[4] made a similar operation to that of Galezowski, just mentioned, but before rolling the pterygium upon itself, he applied the galvano-cautery to its posterior, or raw, surface. This was supposed to hasten the atrophy of the growth. Deschamps[5] affirmed that cauterism of the corneal portion, when well done, especially if combined with a good scraping, rendered any sort of conjunctival autoplasty inutile, and that the cure was rapid and permanent. *Most all authorities agree that it is highly indiscreet to cauterize the episcleral part of the wound opening.* It should also be borne in mind that the electric cautery is, in this respect, an instrument whose employment should be confined to the most experienced and skillful hands, as in any other than these, because of its tremendous energy, its work is sure to be overdone and deep scars be the result. Unless one is sure of himself, it were better to employ for the purpose the iron made red-hot in the flame. The actual cautery is particularly helpful in getting rid of the infiltrated head that sometimes thwarts one's efforts at dissection and scraping, and whose complete removal is of the utmost importance.

Starkey,[6] of Chicago, recommends the galvanic current for the

[1] Operationslehre, S. 381.
[2] Annal. d'oculist, 1881, p. 144.
[3] Maladies des yeux, 1894, t. ii, p. 265.
[4] Archiv. d'opht., t. xi, p. 528, 1891.
[5] Bull. et mém. de la Soc. franc. d'opht., 1895, p. 510.
[6] Journal of the Am. Med. Association, Sept. 11, 1898.

treatment of pterygium, but not to the extent of actually burning the growth, but for its milder electrolytic effect. Among the other procedures employed as adjuncts to pterygium operations may be mentioned conjunctival autoplasty by means of mucous grafts[1] and of Thiersch skin grafts.[2] The last mentioned took from behind the ear an epidermic graft somewhat smaller than the scleral defect, and, in order to prevent overlapping of the corneal margin, fastened it in with two fine sutures at a little distance trom the limbus. Grafting is applicable to either ablation or transplantation, and the method of Hotz is an excellent one. Thin epidermis furnishes more suitable material for the purpose than does mucous membrane. It is more easily kept in position, it does not become red and meaty, it is less likely to perish, and its whiteness, lying as it does upon the sclera, is a positive advantage. Such accessory measures are, of course, reserved for the larger pterygia only.

False pterygium, also known under the names *cicatricial pterygium*, *pseudo-pterygium*, and *pterygoid*, refers to an irregular growth of conjunctiva taking place upon the cornea, as a result of burns and other lesions, and its approach may be from any direction or from several different points at the same time. Under this heading may also be placed that unfortunate class of cases wherein there have been recurrences of the pterygium after operations for its removal, and there is a sclerotic degeneration of the cornea, or a condition resembling the so-called *keloid* cornea. Where these are present, are not progressive, and the sight is not greatly diminished in consequence, one would better abstain from further operative measures. The exaggerated forms tend more or less to restrict the movements of the globe and to produce strabismus, which constitute additional indications for surgical intervention; and they are often associated with symblepharon (*symblepharo-pterygium*). In its surgical treatment, therefore, false pterygium involves many of the principles which are concerned in operations for symblepharon as well as most of those just described in connection with the true form. No set methods can be laid down for their operative handling, as they present so great a variety that each case must be separately reckoned with.

[1] S. Klein, Allgem. Wiener med. Zeitung, 1876, Nos. 3 and 4.
[2] F. C. Hotz, of Chicago, Klin. Monatsbl. f. Augenh., 1897, p. 610

Great care should be exercised in the process of uncovering the cornea where the destruction of that membrane has been deep, lest the anterior chamber be opened. Optical iridectomy is occasionally required in connection with cicatricial pterygium.

The tendency of pterygium to return after operations, seems to depend upon the manner of its removal. Failure to cure does not hang so much upon the specific method that is chosen, nor, as was formerly supposed, upon any inherent proneness of these growths to recidivate, as upon the neglect or the lack of certain essential conditions. Among the causes of non-success stress is laid upon the following:

(*a*) Failure to properly cover the scleral defect or so to fix the covering as to keep it away from the cornea.

(*b*) Incomplete removal of the growth from the cornea, especially the head.

(*c*) Want of care in placing the conjunctival sutures. Pulling and tearing the delicate membrane, using needles and thread that are too large, and taking with them *bites* that are insufficient.

(*d*) Leaving a thick growth of episcleral tissue at the corneal margin.

(*e*) Operating when the whole conjunctiva is hyperemic or inflamed.

(*f*) Inadequate bandaging and allowing the patient too much liberty during the first few days after the operation.

The causes (*a*) and (*d*) are those that are, perhaps, most often operative. After having removed a pterygium, no matter by what method, if the sclera adjacent to the cornea is left exposed over an area, say of one-half a square centimeter, the defect were better covered at once. A most satisfactory manner of doing this is by means of a Thiersch graft, as first practised by the late Professor Hotz, of Chicago. The graft is taken from the inner side of the upper arm or from behind the ear, and is cut so that it bridges the conjunctival gap in the vertical sense, but is narrower in the lateral sense. It is placed in the middle of the scleral defect and held in position by two sutures, one above and one below. Thus the graft keeps clear of the cornea. Thiersch epidermic grafts are preferable to those that are shaved from the mucous membrane of the mouth,

because they remain white, while the mucous grafts never lose their redness. Besides, the latter do not lie so smoothly, but become bunchy from thickening, and from lateral contraction. It is of the utmost importance that the patient be instructed to clean the dead epithelium from the graft every day or two with warm boric acid solution and a cotton swab.

The other cause of recurrence referred to under (*d*)—leaving a thick growth of episcleral tissue about the corneal margin—can be rendered inoperative by scraping away this growth very thoroughly, leaving the sclera quite bare.

Gifford,[1] of Omaha, in an article on "Recurrent Pterygium," cites Knapp's well-remembered warning, viz., "Pterygia that have relapsed after one or several operations and have the aspect of a keloid scar should not be meddled with." Gifford then says, "The condition of this class of patients is so deplorable that it would be unfortunate if this verdict of so high an authority should be considered final. I have seen several of these cases, and my experience has led me to an entirely different opinion." And, further, "My experience indicates that all of these bad cases of recurrent pterygium can be cured if a large enough Thiersch flap or epithelial lip-flap is put on. In doing the operation it is important, in dissecting back the conjunctiva, to clean the cornea and sclera very thoroughly and to be sure that the flap is well attached to the globe before the lids are allowed to close. The device which I have adopted of fixing the globe in a position of abduction by means of a guy-thread put through the tendon of the external rectus and fastened to the skin outside the external canthus with collodionized gauze to prevent displacement of the flap may be necessary in some extreme cases. But if the flap is pressed down firmly with an absorbent cotton toothpick swab, slightly moistened, so as to bring its entire under-surface into close contact with the globe, and the lids are held open for three to five minutes thereafter, then both eyes kept closed with a rather firm bandage, with plenty of cotton, for 48 hours, failures from displacement of the flap will be rare.

In applying the latter it is sometimes necessary to tuck the edges in under the loosened conjunctiva, and I have once or twice protected

[1] Ophthalmic Record, Jan., 1909.

he well-applied flap by temporarily drawing the conjunctiva partly over it with a suture. The flap should be slid directly from the razor to the globe. It should be cut large enough, and, after covering the defect on the globe, the excess on the temporal side is trimmed off so as to leave bare the cornea and a strip of sclera about 1/16 inch wide between it and the flap."

What appears at a glance to be a recidivation is sometimes but the vascularized and otherwise changed condition of the cornea in the locality that had been occupied by the pterygium. This may or may not wholly clear up. The immediate status of the vision after the removal of pterygia that encroach even very slightly upon the pupillary area is apt to be disappointing, owing to the fact that there is usually some disturbance of the cornea which extends beyond the apparent limits of the growth. A little time is required for this to disappear.

PERITOMY AND PERIDECTOMY.

According to the researches of Hirschberg the Arabian surgeons, early in the Middle Ages, made circumcision of the cornea for the pannus of trachoma.

In the year 1862, Fournari or Furnari,[1] of Paris, afterward of the University of Palermo, published the description and the results of his experience with an operative measure which he claimed to have employed with success while previously, for twenty years, a resident of Algeria. The author called it *tonsure de la conjonctive bulbaire*. It consisted in the excision of a ring of the conjunctiva immediately surrounding the cornea and the application of nitrate of silver to the annular defect, together with the scarification of the anomalous corneal blood-vessels. Afterward the operation was named *peridectomy*, and still later *syndectomy*, both of which words refer to the removal of the aforesaid ring of conjunctiva, and, strictly speaking, should be so used in contradistinction to *peritomy*.

This last is a term that was applied by Critchett, of London, to a modification of Furnari's operation, which he devised. The chief change suggested by Critchett was that the word implies, viz., the

[1] Gaz. méd. de Paris, 1862, Nos. 4, 6, 8, 10, 12, 14 et Annal. d'oc., 1863, t. xlix, p. 272.

substitution of a simple circum-corneal incision for the excision. What Critchett really did, then, was to rehabilitate the old Arabian measure.

The indications for peritomy and for peridectomy or syndectomy are the same, to wit, a pertinacious vascularity of the superficial portion of the cornea, whether consecutive to trachoma, interstitial keratitis, leucoma, or aught else. The measure has also been resorted to with marked success, especially in Great Britain, for episcleritis, iritis, herpes ophthalmicus, purulent conjunctivitis, and even for glaucomatous tension.

Peritomy was further modified by Agnew, of New York, and was one of his favorite means of dealing with persistent pannus. Having been the fortunate observer of much of Agnew's brilliant work, the present writer was led to adopt the method, has employed it many times, and almost invariably with gratifying results. It may be thus described:

Agnew's Method.—The eye is carefully cleaned and put under cocain anesthesia. The lids are held apart by the blepharostat. The globe is fixed and the conjunctiva manipulated with delicate mouse-tooth forceps. The conjunctiva is incised all the way around with a pair of small curved scissors whose points are slightly blunted, but whose cutting power, especially at the extremities of the blades, is absolutely irreproachable. It is advisable that the cut be as close to the limbus as possible, hence these qualities in the scissors are insisted upon. Now the mouse-tooth forceps are exchanged for the broad-jawed fixation forceps.

While the eye is steadied with these, the severed conjunctiva is pushed backward, all around, to a distance of about five millimeters, by means of a convex-edged scalpel. With this same instrument the episcleral tissue is also scraped away till the sclera is quite bare and, where practicable, the scrapings are excised. The larger trunks of the corneal vessels are gently scratched longitudinally with the point of the knife, or, what is perhaps better, each of them is touched where it crosses the limbus with a small, red hot, bulbous electrode. No clots of blood nor shreds of fibrin should be left about the field of operation. The eye is douched copiously with hot boric or hot salt solution, and the regulation monocular netting bandage is put on. The reaction is usually

insignificant. Upon removing the bandage, if it is found that the conjunctiva is creeping forward, it were best to loosen it up with a blunt instrument, push it back, and smear with vaselin.

L. Webster Fox,[1] of Philadelphia, has recently made a plea for the rehabilitation of peridectomy, and states that in 108 such operations, performed by him within the past three years, the results had been most gratifying. He further states, "The operation as performed at present consists in excising a strip of bulbar conjunctiva 2 to 5 mm. wide surrounding the cornea. The vessels on the cornea at the limbus are scarified by means of a Beer's knife, but no cauterant is employed. The eye is anesthetized by the instillation of cocain (5 per cent. solution), and excessive hemorrhage may be controlled by the application of adrenalin solution, 1 to 1000. This is the operation referred to as peridectomy, and should always be combined with treatment directed toward the underlying cause of the corneal vascularity."

I believe with Fox that the operation, whether it be peritomy or peridectomy, particularly the former, has been unjustly maligned. Among those who speak disparagingly of it is no less a person than Knapp,[2] who says, "I have performed it (in reality peridectomy) a number of times. The result was too uncertain and the danger of sloughing of the cornea was ever present. I think the operation has been generally abandoned." The last two statements are most surprising. Most surprising still, the distinguished author falls into the popular error of confounding peritomy with peridectomy, for he calls the operation by the first name and says that it "consists in the removal of a strip, from 5 to 8 mm. in breadth, of conjunctiva around the cornea."

In view of the fact that the vast majority of cases wherein such surgery is indicated concerns eyes whose conjunctival sacs are already shrunken, makes peritomy, in my opinion, by far the more rational procedure of the two. Instead of sustaining a loss the conjunctiva is made to gain, in that the pushing back of the bulbar portion tends to deepen the previously contracted fornices. As to the dangers, I have never seen any untoward consequences from the operation.

[1] Annals of Ophthalmology, Oct., 1903, p. 615.
[2] Norris and Oliver's System, 1898, p. 853.

It is generally admitted, however, that these measures are only to be resorted to when those of a less radical nature have failed to restore to the cornea its transparency. According to Panas,[1] the worst forms of pannus—those known as *crassus* and *sarcomatoid*—are positive contraindications, for which, among other modes of treatment, he suggests pericorneal cauterism, or *igneous peritomy.* For large scattering vessels that have become a fixture in the cornea, I have sometimes caused their disappearance by destroying a small section of each trunk at or near the limbus by means of the galvano-cautery.

[1] Maladies des yeux, t. ii, p. 230.

CHAPTER IX.

THE SURGICAL TREATMENT OF TRACHOMA.

Measures more or less surgical have since the earliest times been employed for the relief of this wretched malady. These measures may be classed as:

1. Mechanical.
2. Chemical.
3. Operative.

Chief among the mechanical are:

(*a*) Scraping, or scratching.
(*b*) Expression, or squeezing.

The chemical are:

(*c*) Cauterism.
(*d*) Radiation.

And the operative:

(*e*) Curettage.
(*f*) Excision.
(*g*) Canthotomy (and canthoplasty).
(*h*) Peritomy (and peridectomy).

It is worthy of remark that all of these measures, as used in this connection, with the possible exception of electrolysis, radiation and canthoplasty, are as old as history itself, or nearly so.

1. MECHANICAL TREATMENT.

(*a*) **Scraping or Scratching.**—This is probably the most ancient of any of the methods enumerated. Under the same heading one may class massage. Primitive peoples afflicted with trachoma, in seeking relief from the itching and other irritating effects of the disease, early learned to evert the lids and rub the granulations. For this purpose they usually sought some implement with a rough

surface or a sharpish edge—fig-leaves, bits of broken pottery, etc. Capt. Cook, on his first visit to one of the hitherto unknown isles of the Pacific, saw a native mother holding in her lap a trachomatous child whose everted lid she scraped with a chip of wood.[1] Hippocrates, to remove the granu ations, made use of a tightly wound mop of raw wool. The name of the mop was *Ophthalmoxistron*, and of the scrubbing *ophthalmoxysis*. Paulus, of Ægineta, employed a similar instrument which he called a *blepharoxystron*, and the operation he named *blepharoxysis*. With these crude things they rubbed until they exposed the tarsus, then applied powdered drugs or the cautery to the denuded part. Severus decried these rude procedures, preferring massage. This was either *simple*, that is, with the bare finger or other smooth object, or *medicamentous*, that is, with the addition of unguents, etc. There have been numerous revivals, within modern times, of the exact principles involved in these ancient practices, and to the same end, though, naturally, with improvement both as to the manner and means. The first modern revival by Woolhouse, in England, at the end of the 18th century, yet with an instrument little in advance of the original ones, seeing that it was a brush made of barbs of grain. The next was by Borelli, in 1859; then, later, by several others; and still more recently (1891) by a number of French oculists and a few in other countries. The French have called the process variously—as *Brossage*, *raclage*, *grattage*, etc. It is not an extremely bad measure, but it is far from being as good as some others. That of *massage*, on the other hand, is a most excellent one; particularly the medicamentous kind, recommended some years ago by Below.[2] This consists in rubbing strong solutions of sublimate, 1–500 up to 1–100, into the infiltrated conjunctiva. After an experience of ten years with like methods, I most heartily commend it to my colleagues. Since the introduction of the organic silver preparations I have found this form of massage particularly effective. There is hardly a stage of the affection to which it is

[1] To prove that such pristine practices have not wholly passed, the writer, not long since, knew a young man who carried in his vest pocket a fragment of window-pane with which he would, from time to time, scratch the upper borders of his inverted tarsi. The trachoma bodies in this instance were scarred veterans, and the noise that he made with his "scratting" was anything but musical.

[2] Jour. de méd. russe, 1885.

not applicable, though it is specially valuable where other means are contraindicated. The writer proceeds as follows: "The lids are cleansed externally with warm boric acid solution. They are then everted and a single drop of adrenalin solution put onto the conjunctiva. A small hard mop is made by winding absorbent cotton on the tip of a carrier. This is dipped into a very hot solution of sublimate, about 1–250 in strength, the lid is again everted and the affected conjunctiva rubbed. The rubbing should be neither too delicate nor too rough, and not prolonged beyond a minute or two, dipping the mop in the hot sublimate now and then, but never leaving an excess of liquid on it, to run down over the cornea and healthy portions of the conjunctiva. Then, without replacing the lids, the whole mucous sac is copiously irrigated for another minute with 4% boric acid solution, *as hot as can be borne.* And, lastly, a drop of cocain solution is put in. This is repeated with two-day intervals, and, on the alternate days precisely the same is done excepting that a 50% solution of argyrol is substituted for the sublimate. If properly carried out, there is no irritation after either treatment."

(*b*) **Expression** of the lymphoid material from the trachoma follicles, in order to hasten the cure, is by no means a recent idea. It was formerly accomplished by means of the finger-nails, and was called *unguipressio.* A number of attempted revivals of it had occurred in the last century, as, for example, by Eble (1828), Pilz (1854), and Cuignet (1873). It was not, however, until its strong advocacy by Hotz,[1] of Chicago, in 1886, that its day really arrived; and it looks as if it had come to stay. Hotz first used his thumb-nails, but soon had the jaws of a pair of old angular forceps made smooth for this purpose. If I mistake not, this was the original expression forceps. Then followed, in 1891, Prince's ring-forceps, Noyes' trough-jawed forceps and Knapp's roller forceps, all in quick succession (see Plate VI). The next year the writer suggested a ring-forceps made of tortoise-shell as an improvement over the steel, in that it would not admit of the same forceful application—hence less severe. The common fault of these instruments is the inevitable traction exerted upon the membrane in stripping the follicles.

[1] Archives of Ophthalmology, vol. xv, 1886, p. 147.

Even that of Knapp, designed after the principle of a mangle, does not overcome this objection. Could one invent a practical roller forceps in which an intrinsic force, other than the pull on the handle, would impart the rotation to the tightly clamped rollers, it would be ideal. Say a band, chain, gear, or screw. Lacking this, the best and most available instrument is the *expresser* of Kuhnt, the working part of which is composed of two coapting, perforated metal plates. The perforations are so arranged that no two come

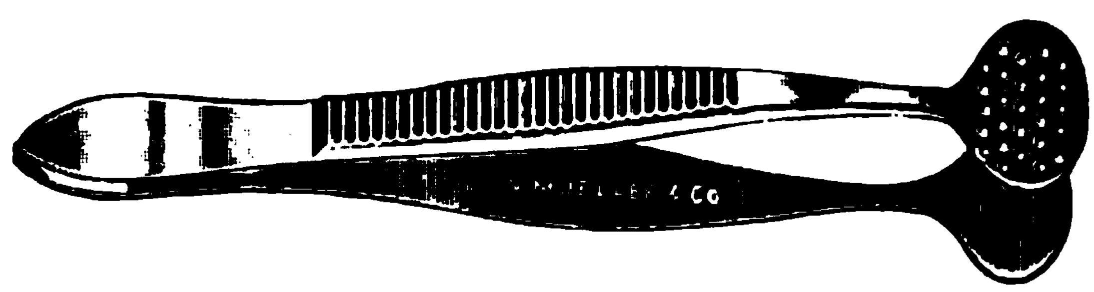


FIG. 206.

opposite, one to the other, and the expression is effected by simple pression, i.e., without traction. In cases of advanced gelatinous degeneration of the fornices, the mere inversion of the lids causes laceration and bleeding. For these Kuhnt has had constructed what, he terms a *modified expresser*, one plate being perforated and the other solid. This he inserts beneath the uninverted lid, finds the infiltrated tissue, and makes gentle pressure. The expressers are made of varying shapes and sizes, in order that one may reach any part of the conjunctival sac (Figs. 206, 207, 208 and 209).

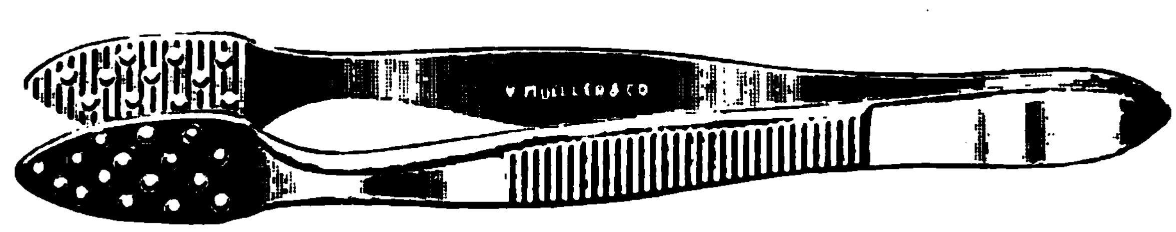


FIG. 207.

Expression is highly efficacious in selected cases. It shortens the course of treatment, forestalls ulceration of the cornea, prevents pannus, and reduces cicatricial contraction to the minimum. It is almost painless under the topic application or the submucous injection of cocain. It is simple of execution, and safe as to consequences. Patients may be operated on and allowed to depart at once for home, provided they live within calling distance, being instructed to keep quiet meanwhile and to bathe the lids with very hot water. For it must not be understood that they need no after-

treatment. For one thing, it must be particularly seen to that adhesions do not form between contiguous portions of the membrane made raw by the operation. To this end, during the first days thereafter, frequent examinations and, mayhap, the use of a probe, are needed to prevent the formation of cavities and pockets. These would only help to obliterate the already shallowed cul-de-sacs. Repetitions of expression are required as long as any lurking follicles can be discovered, always with a wholesome mistrust of the

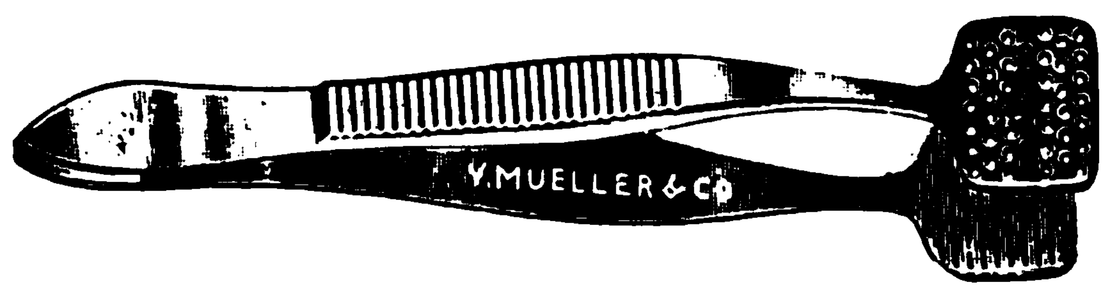


FIG. 208.

fornices and the semilunar fold; and appropriate medical treatment is to be continued until the cure is complete.

The technic of the process of necessity varies somewhat with the kind of instrument employed, but is mainly such as common sense and a thorough knowledge of the nature of the disease and of the tissues involved would dictate. The principal things to be avoided are undue traumatism of the conjunctiva and injury to the corneal epithelium. The prolonged action of cocain, it must be remembered, is bad for the cornea. Every infiltrated follicle must

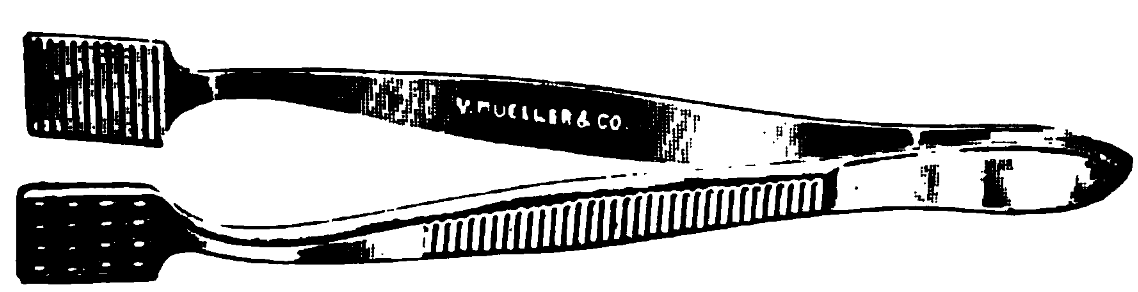


FIG. 209.

be sought out and emptied at the one sitting. After finishing and before replacing the lids, free irrigation of the entire conjunctival surface with hot boric acid or normal salt solution is indispensable.

The time for expression is toward the end of the first, or at the beginning of the second, stage of the disease, i.e., when the granules have become soft or "ripe." This condition occurs when the infiltrated follicles take on a grayish or yellow-gray tint. Then the affected folds and lobules of the fornices are plump but quiet. It is

then that the trachoma bodies assume the appearance so often referred to as that of "frog-spawn" and of "boiled sago." All authorities agree in advising against expression in acute trachoma, or during the first half of the chronic stage, or in a blennorrhagic period, be it in the beginning or during an exacerbation. The most violent outbreaks call for the mildest measures. This is one instance where a desperate case does not demand a desperate remedy.

2. CHEMICAL TREATMENT.

(*c*) **Cauterism.**—In its broadest sense this termrefers to the use of both escharotic mineral substances or caustics and the actual or thermic cautery. Caustics will not be considered. The ancient Greeks and Romans and the physicians of the Middle Ages regularly resorted to cauterization for affections of the conjunctiva, and often in conjunction with scraping or scarifying. To judge from descriptions in their writings, of the implements with which it was done, and from relics of the same that have been preserved, they seem to have taken great pride in these outfits. The first in modern times to employ the cautery for trauchoma was Samelsohn, in 1857. He selected the more advanced cases for its application, touching the separate follicles with a tiny tip of a galvanocautery (punctate cauterization). Reich (1888) and Burchart (1889) were strong supporters of the galvano-cautery for trachoma, but rightly limited its use to the recent cases. Indeed, it is admissible at an earlier stage than any other surgical measure. For the extensive infiltrations, to be properly applied, it is very tedious, requiring many sittings. But for isolated granules and as an auxiliary to other forms of treatment, it is most excellent. To hasten matters, G. Lindsay-Johnson, of London, has resurrected the ancient combination of scarification and cauterism, first incising the conjunctiva horizontally with his triple knife and then tracing the cuts with electrolysis. Neither thermic nor galvanic cautery nor electrolysis have had many partisans of late. They mostly add to the scarring.

(*d*) **Radiation.**—Much is hoped for in the treatment of trachoma or, rather, much has already been accomplished and much more is hoped for from the comparatively new therapeutic agents—X-rays

and radium. Like caustics, they hardly have a place in this treatise, and the reader is referred for details of their management to other sources. Suffice it to state that none but those thoroughly conversant with the properties of these subtle things should attempt to avail themselves of their virtues, for they are as potent for evil as for good.

3. OPERATIVE MEASURES.

(*e*) **Curettage.**—Along with this goes scarification, and both are but phases of primitive methods, such as pricking, scratching, and scraping. The Arabian surgeons Isaac Judeus and Rhazes, a thousand years ago, recommended the sharp spoon for getting rid of trachomatous follicles. Its use was again brought to the front by Bardenheuer, of Cologne, in 1877. The best known and most approved method of employing it is that of Sattler, of Leipsig. After incising each individual follicle, this surgeon proceeded to lade out its contents with a very small curet. Like cauterism, it is not adapted to voluminous infiltrations because of its tediousness and the increased cicatrization that it causes. Unlike it, however, it is not suited to the earliest stages, but to the scattering granulations that have escaped other kinds of treatment.

(*f*) **Excision.**—The fornices, especially the upper, are the store houses or reserve stations of the trachomatous infection. And, as regards resistance to the attacks of any ordinary antagonist, the deeper recesses of the upper fornix are veritable strongholds. They often successfully resist all medical and mechanical treatment. It is from these that start the relapses that have made the handling of these cases so discouraging. Not only does the upper fornix afford the best harbor for the poisonous germs, but the best soil as well. So that, when cured cases are again exposed to a trachomatous environment, the upper fornix has been oftenest the site of a reinfection. Knowing these things doubtless, as well as the fact that the cutting out of a fold of swollen or infiltrated conjunctiva is often mentioned in the Hippocration and other old medical writings, may have been the motive behind the active recourse to surgery in fighting the tremendous epidemic of trachoma that in Europe followed the Wars of the Empire. It is certain that these

considerations actuated Bendedict, in 1822, to remove an occasional fold from the cul-de-sac, and Galezowski, in 1874, to excise the three upper retro-tarsal folds bodily. Galezowski's experiences with the measure must have proven most satisfactory, for he has been industriously at it ever since. Who has not seen the cavalier manner in which he went about it!

Seeing that the tarsus was also often the seat of the trachomatous affection and its complications, Heisrath, of Königsberg, a pupil of Jackson, in 1882, proposed, in fit cases, adding to the exsection of the fornix that of the diseased portion of the adjoining tarsus. Heisrath's idea was taken up and elaborated by Vossius and by Kuhnt. The last-mentioned has been especially instrumental in furnishing details as to the indications and in working out an approved technic. So closely identified is the School of Königsberg, i.e., now, Professor Kuhnt, with everything pertaining to trachoma and its handling that it (or he) is rather looked to as the fountain-head of such lore. It is to this source, therefore, that the author is indebted for most of what follows on this subject.

In this connection there are three kinds of excision, to wit:

1. Simple.
2. Isolated.
3. Extirpation.

1. *Simple excision* means the removal of a strip of the infiltrated conjunctiva, its dimensions being regulated by the requirements present. Kuhnt restricts its application almost exclusively to the lower fornix. Its indications are:

First.—When the other methods have failed or when there are recidivations.

Second.—When the tarsus or the bulbar conjunctiva are becoming involved.

Third.—When there are corneal complications.

Fourth.—When the patient comes from a trachomatous district and will go back to it. The operation is contraindicated when the conjunctiva is at all scant.

Technic of Simple Excision of the Lower Lid.—A few minims of a 10% cocain solution are dropped into the conjunctival sac, and a few drops of a 6% solution of the same are injected into the folds

themselves. The upper lid is held back by an assistant with a sublimated cotton sponge. The patient is made to look far upward, the operator everts the lower lid with his left hand, while with his right he takes a pair of curved scissors, places them, convexity downward, on the conjunctiva, and begins the incision from the outer side. The *plica semilunaris*, if also affected, would better be left for another sitting. If deemed necessary to excise it at once, the resulting wound should not be continuous with that in the fornix, else an ugly scar will ensue. Sutures are usually omitted. After the instillation of atropin and dusting the opening with airol, the eye is bandaged. The dressings are removed at the end of 48 hours, and the conjunctiva is washed with sublimate solution, 1–5000.

2. **Combined excision** consists in cutting out the trachomatous transition folds together with the affected part of the adjacent tarsus, and its sphere is limited to the upper lid. The lower tarsus never requires exsections. The indications for this muco-tarsal excision are:

First.—In all chronic forms of trachoma, with characteristic follicles, associated with infiltration of the tarsus, whether the cornea is involved or not.

Second.—In extensive chronic trachoma of the fornices and palpebral conjunctiva, independent of the condition of the tarsus, *if the cornea is involved or about to be.*

Third.—In gelatinous trachoma, even when mainly confined to the fornices, *if the convex edge of the tarsus shows typical thickening.*

Fourth.—In already cured trachoma of the fornices if the palpebral conjunctiva and tarsus are gelatinous—especially if, in addition, there is secondary affection of the cornea.

The contraindications are:

First.—Recent cases without corneal complications.

Second.—The advent of the stage of scarring, and the granular process has ceased or is in the act of ceasing.

Third.—Marked tendency to shrinkage (Xerosis) of the conjunctival sac.

Technic.—The eye is prepared as for simple excision. The upper lid is inverted and two pairs of special fixation forceps, with catches, are made to grasp the tarsus near its extremities, in the horizontal

sense, and are locked. An assistant, standing at the patient's head, takes the forceps and rotates them so as to still further turn the lid, the patient meanwhile being directed to look forcibly downward, thus bringing the fornix into view. The first incision, through conjunctiva only, is parallel with the convex border of the tarsus, and far enough back to include the diseased folds. The purplish muscle of Müller is here to be avoided. Three sutures are now put through the posterior lip of the wound from the epithelial side, and it is undermined nearly to the globe, while making traction on the threads. The two forceps are now removed, the operator seizes the free border with a Blomer's forceps and the aid places a Jäger spatula behind the inverted lid as a support for the second or tarsal incision. This begins at the inner and extends to the outer canthus, uniting the extremities of the first incision, and includes both conjunctiva and tarsus. It curves slightly toward the first incision so as to leave greater width of tarsus at the center. The widest part of the island thus surrounded should not be more than 1 1/2 to 2 centimeters. The tarsal portion of the island is carefully dissected out with blunt-pointed scissors, hugging the outer surface of the tarsus, and avoiding the orbicularis and the muscle of Müller. The lid is closed, the sutures drawn down straight, the point where each emerges from the free border is noted, the lid turned back, and the needles put through the remaining strip of tarsus at the points indicated, coming out on the conjunctival surface. The threads are tied in single knots, the lid again turned down, and the patient directed to open and close the eyes. If there be any puckering of the lid, it may be best to evert and make further dissection of the posterior flap before tying finally. Ends of thread an inch long are left to facilitate removal. Before the bandage is applied scopolamin is instilled and airol dusted on. The bandage is changed on the third day, and on the sixth day the sutures are removed and the bandage left off (Figs. 210 and 211).

The author has made a number of these combined excisions at the Illinois Eye Infirmary during the past three or four years, and would suggest certain modifications of the technic as just given. First, with regard to the incision through the tarsus. Instead of making it perpendicular to the plane of the tarsus, he would make it slanting upward, as shown in Fig. 210, where the heavy black

line indicates the parts excised. This conduces to less unevenness in the resulting cicatrix. Second, as to the placing and tying of the middle sutures. The usual way is to pass them first through the flap, from the conjunctival surface, then through the remnant of the tarsus to emerge and be tied on the conjunctiva. Now, to avoid contact of the knots with the cornea, which is dangerous as well as painful, he would advise the use of fine, double-armed

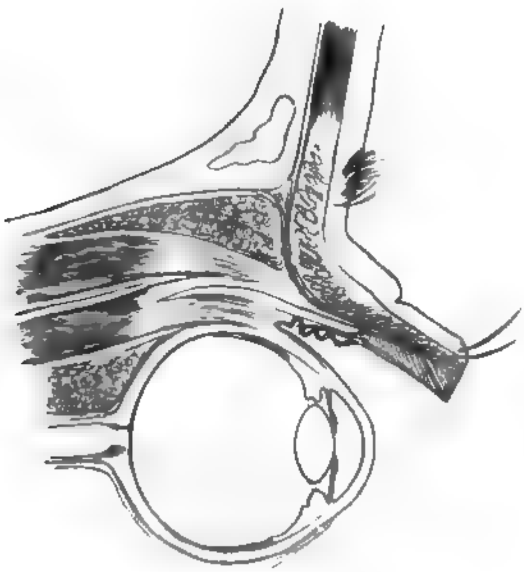


FIG. 210.—Excision of tarsus. The heavy black line surrounds portion excised in extreme cases.

sutures, introduced as follows: one needle passed through the flap of conjunctiva from the epithelial side, then through the remnant of tarsus, coming out at the free border almost in line with the cilia (Fig. 211). The other needle is made to pass through the tarsus in a similar manner, but slightly in front and to one side of the track of the first needle. Both needles are not put through the flap of conjunctiva. The two ends of thread are tied over a long slender cylinder of gauze or absorbent cotton that will fold upon itself without getting into the palpebral fissure. Two such double-armed sutures are required. The two outer sutures are knotted in the

usual way, i.e., on the conjunctival surface. Indeed, if the exsection of tarsus reaches almost to the free border and, as is often the case, the angle there, with the muscle of Riolani has been whetted away, the second needle is not needed the end of thread being simply brought around to be tied to its fellow.

Kuhnt considers the combined excision the best prophylactic against pannus.

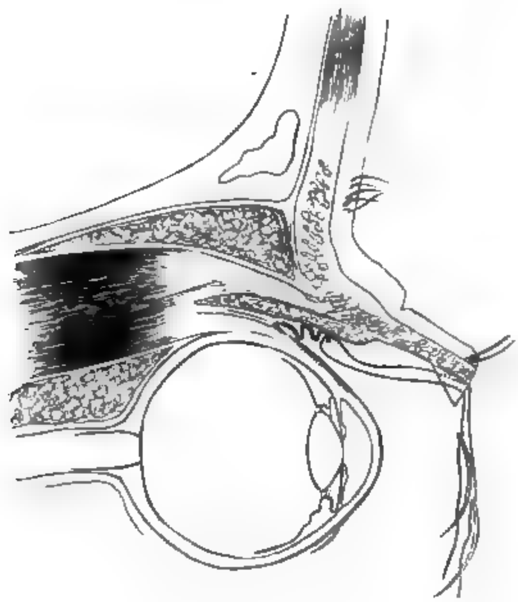


FIG. 211. Combined excision of the tarsus. Disposition of sutures.

3. **Isolated Excision of the Tarsus.**—In this procedure all of the upper tarsus but a narrow strip at the free border is excised; but the overlying conjunctiva is spared. Kuhnt, its author, considers it valuable in the cicatricial stage after the original disease has disappeared, leaving a thick, infiltrated tarsus, exciting pannus, and as a preventive of ptosis and slow atrophy. It is also deemed useful in cases of shrunken and incurvated tarsi, as a relief from entropion, whether or not pannus exists.

Technic.—An assistant grasps the margin of the lid with the Blomer forceps, everts it, and places beneath the now inverted tarsus the Jäger spatula. The operator makes an incision through, and

the whole length of, the tarsus 2 1/2 mm. from the free border, taking care not to wound the fascia underlying the orbicularis. The conjunctiva is dissected from the tarsus, leaving the latter exposed. The cartilage is then separated from the pretarsal connective tissue up to the convex border by means of blunt-pointed scissors, and, lastly, it is detached from the levator tendon. As a rule, sutures are not required. The after-treatment is the same as for the combined excision.

The operation just described is, I believe, comparatively seldom resorted to. The combined excision, however, is in constant requisition in Königsberg. Kuhnt alone has performed it more than 5,000 times. He sums up the results thus:

1. The course of the disease is shortened, the time required for a case being, on an average, six weeks, including after-treatment. He declares that expression cures only 10% of the cases, while excision cures 50 to 60%.

2. Secondary corneal disease is prevented, or, when present is more quickly cured.

3. The mechanical ptosis is corrected.

4. Recurrences are less frequent.

The objections to the measure that have been urged are too much loss of conjunctiva, limitation of ocular movements, and serious cicatricial contraction. To obviate the first, Kuhnt operates only upon eyes with sufficient conjunctiva. As to the second objection, he counsels the invariable conservation of the bulbar conjunctiva, even when it is infiltrated, and treating it by medical and mechanical methods. With respect to the third, it is declared that since only portions of the conjunctiva and tarsus are excised and all the deeper tissues are avoided, the resulting scars are superficial—hence harmless.

It is rather singular that so few operations of either simple or combined excision are made for trachoma in this country. We have large areas in the State of Illinois where trachoma is endemic and has been for fifty years or more. Vast numbers of the victims are treated both in Chicago and in St. Louis, yet one rarely hears of even simple excision; more rarely of combined. Two reasons occur to me for this: First, the character of the people. They are of a peculiar type—shiftless and ignorant beyond belief—and from

some unexplained cause, the majority come for treatment in the very last stages of the disease. Second, as regards the minority who come in the early or middle stages, they are, for the most part, so circumstanced, either from being cared for in a charitable institution, or from having nothing to call them home, that they are content to worry along with conservative measures. When it comes to a discussion of more radical steps the surgeon in charge, unlike our European confrères, in like situations, has precious little to say in the matter. The reason we do not make enucleation of the tarsus (isolated) oftener in these old cicatricial cases is, I fancy, because of the high state of efficiency to which the combination operations for trachomatous entropion and trichiasis have been brought in the United States.

A New Method of Operating in Pannus.—Primrose,[1] William, Glasgow. This writer describes a very simple operation which he has found satisfactory; it consists in causing an extravasation of blood into the subconjunctival tissue around the cornea, which by mechanical pressure and irritation sets up localized inflammation and thus causes obliteration of the vessels which vascularize the cornea. The point of a small sharp-pointed knife is passed through the conjunctiva 2 or 3 mm. from the cornea, made to puncture one of the large blood-vessels, and then withdrawn. The conjunctival wound should be as small as possible and oblique; in this way there is no external hemorrhage; the subconjunctival bleeding is arrested by pressure of the extravasated blood upon the vessel walls, and thus many of the smaller vessels are closed; this mechanical action is increased by the information of a coagulum, the fibrinous part of which shrinks.

"Extravasated blood acts as an irritant, probably chemical as well as mechanical, so a non-infective inflammation is set up which results in the absorption of the blood-clot. This process acts as a counterirritation to the inflammation of the corneal tissues and so tends to remove the seat of inflammation and the supply of blood from the diseased cornea to the clot, where the effects of the inflammation are comparatively trivial. By the time the blood-clot has disappeared the blood-vessels in the cornea affected by the operation have shriveled up and the cornea has regained much of its trans-

[1]The Lancet, April 21, 1906.

parency. The whole pannus may be treated in this way at one time or the operation may be repeated from time to time, only a part of the pannus being treated each time. The latter is always advisable when the pannus is marked, as the inflammatory reaction is sometimes very severe and accompanied by a good deal of pain. Although the structures in the anterior part of the eyeball are all more or less affected by the inflammation, this is easily controlled and subsides in a few days with the application of suitable remedies."

In the classification of surgical measures for trachoma given at the beginning of this chapter occur two other operative ones, viz.: (*g*) *canthotomy* and (*h*) *peritomy*. The technic and the indications for them have been given elsewhere in this volume, and they are mentioned here only by way of completing the list.

CHAPTER X.

OPERATIONS UPON THE GLOBE.

FOREIGN BODIES IN THE CORNEA.

About two-thirds of all the foreign bodies that enter the eye find lodgment in the cornea. Fortunately, most of them are tiny particles that strike with feeble momentum, such as bits of cinder, iron, emery, etc., and do not penetrate beyond Bowman's membrane, and, once located, their removal is simple. Whatever of difficulty attends the operation is, usually, that of finding the offender and keeping it in view. A particle so minute as to be invisible to the unaided eye can be the source of great and prolonged irritation. Such a foreign body is particularly hard to see when its color offers no contrast to that of the iris or pupil and when it has but recently entered the cornea. After resting in the same place a few days a tiny zone of gray infiltration surrounds it, which serves better to reveal its position. If the characteristic symptoms are present and careful inspection in bright daylight and with the use of convex lenses and focal illumination fails to show the foreign body, recourse is had to artificial light and the binocular loop. The patient is placed where a good artificial light is near on the side of the affected eye, almost any kind of light will do, but if it be an unground incandescent electric lamp, it were better to cover the bulb with a sheet of white tissue-paper. Again, oblique focal illumination by means of a 2- or 3-inch biconvex lens, of large diameter, while the operator wears, strapped to his head, a binocular loop. Search is made by directly concentrating the rays upon the epithelium, i.e., keeping the image of the lens as much out of the way as possible. If this fails, a broad image of the lens is thrown on to the cornea, and in the area of this reflection is sought a break that might indicate the mote. Specks of transparent substances, like glass or sand, will sometimes elude any form of seeking except the last. If the quest prove specially trying, a drop of 1% fluorescin solution put on

the cornea would aid by causing a tiny green stain at the site of the foreign body. Throughout all the scrutiny the patient is told to turn the eyes in various directions to favor the search. Having once found the foreign body, it is easily seen afterward. If the eye has not already been prepared, it is now. One should be as scrupulous as to cleanliness of everything concerned as if for an extraction of cataract. Warm boric acid solution is the best thing with which to bathe and douche the eye. Cocain, or its analogue, is all that is needed in the way of anesthesia. I have never yet had to resort to narcosis, yet one can imagine how this might become necessary. In cases of little children, they are put in the position described under "Applications and Dressings." If there be much hyperemia, a drop of adrenalin chlorid or similar solution is put in just before the anesthetic to blanch the conjunctiva.

The best all-around **form of instrument** is the sharp, grooved spud or gouge (Plate II, No. 42), thoroughly disinfected. A discission needle is also a good instrument, provided it is not too sharp. The foreign body being of the kind that requires artificial light to show it, the lens to illuminate the spot is held by an assistant. If no one is by to help, the best substitute is one of the several forms of lens-holder. This is a head-band with jointed ball-and-socket bracket for carrying the lens, and is made fast to the patient's head. If this is not available, the patient, if one of average intelligence, can be made to focus the light, meanwhile supporting the hand that holds the lens against the cheek.

Mode of Procedure (Fig. 212). The patient, with a towel covering the hair, is placed in an ordinary chair of suitable height, behind which stands the operator. No lid speculum is used, as this would necessitate fixation forceps also. The head is held firmly against the surgeon's breast by pressure of the base of the left palm on the forehead, while the eye is held open and the globe is steadied by pressure of the first and second fingers, the first upon the upper lid and the other upon the lower. The patient is made to look in the direction that gives the best view of the foreign body, which is lifted out in such a way as to produce least disturbance of the corneal epithelium. The practice of using very blunt instruments or of wiping the foreign body off the cornea with a mop made by wrapping cotton upon some small implement cannot be too strongly

discouraged. If it be a particle of iron or steel, a reddish stain will be left behind; if a cinder or bit of emery that has entered the eye while very hot, its bed will be a whitish eschar, and, if some days have elapsed since the accident, it matters not what the nature of the substance is, a layer of softened tissue will surround the foreign

FIG. 212

body. In every case the little excavation should be scraped clean by a sort of rotary handling of the gouge. If this is not done, the condition of the eye may be worse than before. In the process of loosening the foreign body and cleaning out its bed it is best that, in a general way, the movements of the point of the instrument be

directed *toward* the center of the operative field and *from* every part of the periphery. Thus one avoids leaving tags of epithelium and flaps of Bowman's membrane around the place to harbor bacteria and increase the dangers of infection. After the operation, another copious douching of the cornea with warm boric acid solution and instruction that the eye be bathed a time or two in very hot water, and all is done that most cases require. A class of corneal injury common in the United States is that from explosions of gunpowder, and requires a management quite peculiar. The unburnt grains go rather deeply into the cornea, but rarely perforate it. To dig at them, particularly when the injury is recent, but results in further traumatism without attaining the main object. Even when one succeeds in removing a grain, it is broken, and a black stain remains behind. It is best to wait from 48 to 60 hours, meanwhile watching the eye and keeping it from infection by mild antiseptics, and under other appropriate treatment, when it will be found that the grains have become loosened. If the eye is then irrigated copiously with boric acid solution, cocainized, the patient put in the recumbent position and a few drops of H_2O_2 instilled, the lids being held apart to allow the liquid to overlie the cornea, most of the impacted foreign material, be it powder or other débris, will come away. The peroxid attacks the softened envelope, and the gas that is generated forces the foreign body out. At the same time, the powder that is in the lids and face is treated by rubbing the skin vigorously with absorbent cotton wet with the peroxid.

Larger foreign bodies have often to be dealt with differently. It may be that one has struck the cornea so obliquely and with such force as to have plowed its way for some distance beneath the surface. It were best here to slit up the track of the foreign body before attempting to dislodge it. Or, again, a particle may have stopped just short of dropping into the anterior chamber and yet not be accessible by forceps, and so nearly through that it were unwise to use the gouge. In this case one might have recourse to the method of Desmarres, viz., that of passing a broad needle or Beer's knife through the base of the cornea into the anterior chamber immediately beneath the foreign body. Upon the ensuing evacuation of the aqueous, the blade of the instrument will tend to press the piece upward, and, at the same time, form a solid foundation upon which to work. If

the foreign body be of steel or iron, however, and so imbedded that it cannot readily be got at with other instruments, it can surely be removed by some form of magnet. If sufficiently loose, a horse-shoe magnet or the Gruening pocket-magnet. If more tightly fast, the Hirschberg electro-magnet or the giant electro-magnet of Haab, or a modification of it. Traction should, of course, be from the same direction as that in which the foreign body entered. More explicit instructions for the use of the magnet are given in the chapter on "Foreign Bodies within the Eye." Atropin and an occlusion bandage, in addition to the mild antiseptic irrigation, are the rule in the severe cases.

ABRASION OF THE CORNEA.

This consists in scraping, shaving, or excising from the cornea varying amounts of its substance for the removal of opacities. It is a very old procedure, having been practised long before Galen's time. This surgeon employed it for certain forms of superficial corneal opacity. Malgaigne,[1] having concluded from experiments upon animals that half the thickness of the cornea could be removed without leaving an opacity, proposed giving the operation a much wider range of application. Notwithstanding, the fact remains that, owing to their depth and the replacing of the lost substance by opaque tissue again, very few of the many forms of opacity will yield to such treatment. This is not to say, however, that the operation has not a wide sphere of usefulness. This is particularly true of the scraping method.

Indications.—It is most frequently indicated in deep slow ulcers, such as those at or near the center that have been left from phlyctenular keratitis, the removal of foreign bodies, etc. These, being so removed from the vascular zone, often become filled with a mass of detritus and all efforts at repair cease. It has also been extensively used in the more active, infectious ulcers of the cornea, principally in the serpiginous. Meyerhöfer,[2] instituted a method for the treatment of such ulcers that has been extensively followed, viz., curetment of the ulcer and its infiltrated border with a small sharp spoon, filling the remaining cavity with iodoform powder

[1] Annal. d'oculist., 1843-45.
[2] Kl. Mbl. F. A. S. 151, 1884.

and bandaging. The lost substance is thought by many to be replaced much more quickly and with less opacity after abrasion than after the cautery. In the days when collyria containing *subacetate of lead* was such a universal remedy for "sore eyes," abrasion was frequently and successfully called into requisition for the removal of the peculiar, opalescent metallic deposits they occasioned. One rarely sees them nowadays. Other indications are the thickened, opaque epithelium resulting from pannus, the so-called girdle-shaped opacity, the black film caused by powder explosions, and characteristic chalky deposit consequent upon certain chronic diseases of the eye, especially those of the uveal tract. This deposit, which has also been called "ribbon-shaped keratitis," is most distinctive in appearance, resembling nothing so much as the frothy, glistening white stuff one often sees overlaying portions of the cornea in elderly people, and that has been expressed from the Meibomian ducts. Leber has recently shown that it is calcific degeneration of Bowman's membrane. It yields readily to ***abrasion.*** The nebulous opacities, which result from superficial keratitis, have sometimes been removed in this way. Indeed, as it is a relatively harmless procedure when done under favorable conditions, it ought oftener to be tried where there is any likelihood of the opacity being shallow.

The operation is simple and easy. Local anesthesia is best when practicable; when not, chlorid of ethyl or similar narcosis. The lids are parted by the blepharostat and the eye steadied with fixation forceps. The scraping instrument may be a small, very sharp spoon or small convex-edged scalpel that is exceptionally keen. In scraping it is best to work always from the periphery of the spot toward its center so as not to leave the edge of the surrounding layers loosened and lifted up. One has only to scrape until clear or sound cornea is reached, irrigate thoroughly, and bandage. A septic condition of the conjunctiva or of the lacrimal canal are contraindications.

The shaving and excision processes are not so much to be recommended. In the first, the opacity is pared away by means of a knife or curved lancet. In the second, the edge of the area is outlined with the point of a knife and the flap dissected out with tiny forceps and knife.

CORNEAL CAUTERY.

Cauterization in some form or another for the treatment of affections of the eye has so wide a range of employment and, as a surgical measure, its application in most instances is so similar, that opportunity will be here taken, once for all, to say a few words relative to its use in general as well as to that in connection with the cornea. For the rest, it will be treated of under the different headings wherever it finds a place.

One distinguishes three kinds of cautery, viz., 1. the chemic; 2. the thermic, and 3. the electric. The first includes those substances which, brought in contact with the tissues, cause an eschar by various forms of chemical action, such as nitrate of silver, for example. Their modes of application are described in the chapter on that subject. The other two refer to those where heat alone is the agent which produces the decomposition and are identical in their effect, the only difference being as to the manner in which the heat is generated. The second kind is usually spoken of as the *actual cautery*, and the third as the *galvano-cautery*. The thermic cautery has been an adjunct to surgery since the earliest days of medicine, and the instrument to receive and apply the heat has been made of a variety of materials. Its best modern representative is a platinum wire of suitable dimensions and shape of tip, supplied with a handle of wood or other non-conductor of heat. In an emergency one can easily improvise such a cautery from a bit of wire or other small metal implement. The best means of heating it are the flame of a spirit lamp or that of a Bunsen burner. "Cherry-red" is the term used to denote the degree of heat which is most serviceable.

The Paquelin appliance is also a handy form of actual cautery.

As concerns the electric cautery, since its introduction by Legroux[1] it has largely supplanted the other two in the hands of the ophthalmic surgeon, partly because of the greater convenience. A small storage battery weighing 6 or 8 pounds will supply an ample current for many operations. Moreover, seeing that the home of the oculist is in the city, he can always have access to the street currents, which he converts to this use either by means of a transformer or of a

[1] Ann. d'oculist. t. 81, p. 181, 1879.

permanent battery and rheostat. Even the electrodes, handles and platinum tips can be interchangeable between the portable and the stationary apparatus. The handle and wires should be as light as possible, and the button for making and breaking the current should be easily manipulated by the tip of the forefinger (Fig. 213). The form of the points is a matter of individual preference. Perhaps the best adapted to all around work is the simple, almost closed loop of round or slightly flattened wire, though the olive tip is excellent in many cases (Fig. 214).

FIG. 213.—Electric cautery. The conductors go over operator's shoulder.

The electro cautery has enjoyed a deserved degree of popularity in the treatment of corneal ulcers, but the necessary accessory equipment for its use is frequently not available when it is most needed and it is always open to the objection of a clumsy handle and difficult regulation of the current so as to produce the desired amount of heat. The demand for a simple, effective, and ever ready instrument has produced Wordsworth's cautery (Fig. 215), consisting of the regulation instrument handle and shank, on the end of which is a copper bulb about five millimeters in diameter. The end of the shank is bent at an obtuse angle so as to allow a good view of

the field of operation. One side of this copper bulb is drawn out into a blunt protuberance for use in the cauterization of comparatively large surfaces, while at another point on the bulb is attached a delicate, short platinum rod for use on small surfaces. The bulb and point will remain sufficiently hot to cauterize for several minutes after being heated to a cherry-red over a flame.

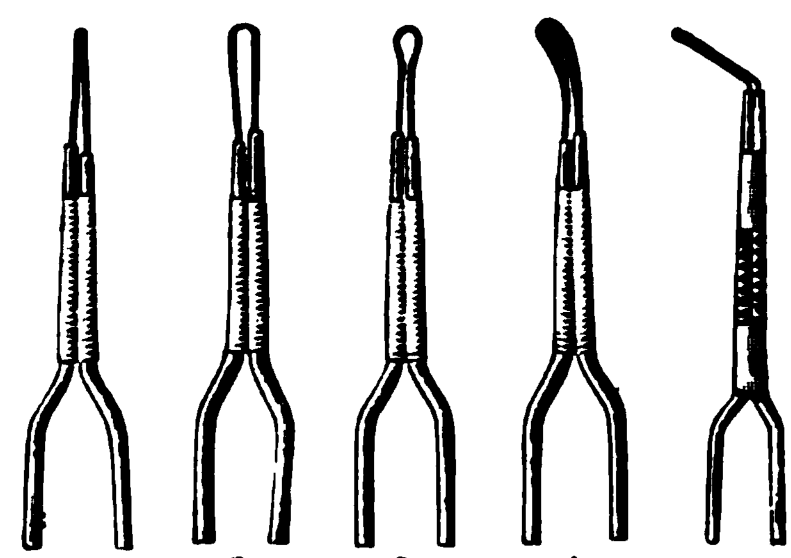


FIG. 214.

To Make the Cautery.—The eye is prepared and anesthetized. The speculum is put in and the globe held by fixation forceps. Having seen to it that the apparatus is in working order, an assistant supports the electrodes while the surgeon applies the tip. Some prefer to lay the cold tip on and heat it *in situ*. Seeing, however, that the performance should be a mere touch, it would seem that greater precision can be attained by holding the wire close to the place to be burned, heating it to the right color, then deftly making the contact. If the tip is allowed to become white-hot (incandescent) its energy is too great, and besides, the light startles the patient. The touch must be particularly quick as regards the cornea, lest steam be generated in the aqueous. It is much better to make several brief applications than attempt too much with one.

Since the year 1873, when Martinache, of San Francisco, first called attention to its virtues in the treatment of *ulcers of the cornea*,[1]

FIG. 215.—Wordsworth-Todd cautery.

the cautery has come to be a standard remedy for all such infectious diseases as serpent, fascicular, annular, dendritic and rodent ulcers, ulcerated wounds, and the ulceration incident to purulent ophthalmia.

In addition to the rules governing the general method of ocular cautery just given, there are a few points relating to corneal cautery

[1] Pacific Med. and Sur. Journal, Nov., 1873, p. 294.

in particular that it were well to mention. If, for instance, the ulcer is filled with curdled pus or other débris, it had better be cleaned out beforehand, as otherwise the operation would be cluttered. Then, if a drop of a 1% solution of fluorescin is put on at the cornea, it will materially help one to distinguish the diseased tissue from the sound, for the resulting green tint will not only show the lateral dimensions of the ulcer and its zone of infiltration, but also their depth. Czermak recommends touching first the infiltrated portion, making a series of small burns close together, and, lastly, the center or ulcer itself, the last either by the small points or by a somewhat larger tip.

Descemet's membrane should be spared whenever possible. It is the great safeguard of the anterior chamber. Not to wound it when the ulcer is deep requires great delicacy in handling the tip. To puncture it with the cautery also increases the risk of complications. If hypopyon, which ordinarily can be ignored, should be present, it would obstruct the perforation and prevent healing. The eye is bandaged after the operation and the patient kept quiet. If necessary the cautery may be repeated.

Another form of corneal ulcer in which cautery gives most gratifying results is the narrow, deep, round, central one, especially when this is complicated by a tiny hernia of Descemet's membrane. When these conditions are present there is, often apparently, no attempt at spontaneous healing. I have seen such cases that remained unaltered for months. It might be that the subject was young—as they mostly are—in perfect health, and receiving every other appropriate form of treatment for the eye, even to the pressure bandage. If any change occurred, it was a slow one for the worse. This was probably from pressure of the protruding membrane on the tissue which surrounds it, for there is always a narrow ring of gray next the hernia that, I take it, indicates a mild form of pressure necrosis. One or, at most, two, applications of the galvano-cautery will effect a speedy cure. Of course, in this instance, Descemet's membrane is instantly perforated and the aqueous spurts, but, owing to the absence of infection, and to the small size, and position of the opening, no trouble with the iris ensues.

Incisions of the Cornea; Paracentesis. Punction.—The number of indications for opening the anterior chamber that have,

first and last, been supposed to exist, is infinite. In truth it has, perhaps, a broader field of alleged utility than any other operation that is made upon the eye. The following are some modern applications:

1. **In Acute Glaucoma,** whether (*a*) *idiopathic* or (*b*) *secondary.*

a. Given, a case of acute glaucoma, with great pain, hyperemia, chemosis, etc., and it is not practicable to give a general anesthetic for iridectomy. It is well known that cocain has no effect in such cases, yet it would be possible to make a simple incision at the base of the cornea with far less additional suffering on the part of the patient than to go ahead with the iridectomy. Having relieved the tension, the iridectomy, if still necessary, could be made after a few days under cocain. Moreover, the chances of loss of vitreous and of choroidal hemorrhage would be lessened by the preliminary incision.

b. In acute secondary glaucoma, such as that from the swollen lens after discission, and after accidental traumatism, paracentesis is imperative. Under these conditions the procedure is usually accompanied by the extraction of lens substance. I have had occasion to make the operation in fulminating glaucoma due to dislocation of the lens into the anterior chamber, not daring, for the moment, to attempt extraction.

2. In certain cases of *blood in the anterior chamber.* Ordinarily these are let alone, and the blood is promptly absorbed. If, on the contrary, it remains for 5 to 7 days without appreciably lessening in quantity, it would better be got rid of, as it may lead to the so-called spongy iritis or organized clot and other dangers. When present as the result of an injury, the blood could cause a foreign body within the eye to be overlooked. Haab mentions the possibility of a hyphema occurring and obstructing the pupil in a case where one is interested in ophthalmoscopic observations, as, for instance, the development of a neoplasm.

3. **In Iritis and Iridocyclitis.**—At the height of the inflammatory process there often comes a time when, because of the hyperemia, etc., the iris and the ciliary muscle cannot be made to respond to the mydriatics and cycloplegics employed, nor do soothing remedies serve to relieve the severe pain in and about the eye. As was pointed out by Abadie,[1] free punction of the cornea makes the eye

[1] Gaz. des hopitaux, p. 219, 1874.

more responsive to treatment and the patient more comfortable. Under these conditions the operation would need to be performed under narcosis. There is another class of cases of uveitis, mostly chronic, characterized by descemetitis, increased depth of anterior chamber, cloudiness of vitreous, recurrent intraocular hemorrhages (or not), and, rarely, notable disproportion between the amblyopia and any apparent cause for it. These, too, are sometimes helped by paracentesis; and, as they are among the most tedious and trying of all our charges, and the operation is, to say the least, harmless, one is justified in trying it.

4. **In ulceration of the cornea** that threatens to perforate, whether there is hypopyon or not. Apropos of the last, before the time when the profession had learned to rely upon the efficacy of antiseptic treatment for these infectious conditions, it was the rule to make paracentesis in cases of hypopyon. Consequently, eye after eye was lost. This was true even in the earlier period of antiseptic medicine, when the case was having this treatment in addition. At present, eye after eye is saved by disregarding the hypopyon, using copious irrigation with mild antiseptics, atropin, and, above all, the roller bandage. Paracentesis in any form, according to the Saemisch or otherwise, has largely given way to the non-operative treatment.

5. **In Conical Cornea.**—(See section on *Keratoconus.*)

6. **In Embolism and Thrombosis of the Retinal Vessels.**—Paracentesis of the cornea has been suggested as an adjunct to massage. One would hesitate before making the operation, however, in cases of advanced arteriosclerosis. It would seem from the researches of Fuchs,[1] relative to the nature of panophthalmitis and the course of the infection therein, that paracentesis may find an extension of its sphere in helping to save from enucleation some of the eyes thus afflicted.

Von Graefe,[2] proposed punction of the anterior chamber in glaucoma simplex, as a sort of guide as to whether or not an iridectomy would prove beneficial. One is often put in a quandary when dealing with this disease. For example, in spite of other means of treatment the sight is fast going and the fields rapidly dimin-

[1] Arch. f. Augenh., lviii, 3, S. 301.
[2] A. F. O., xv, 3, 211.

ishing, yet one shrinks from an iridectomy, and posterior sclerotomy is out of the question. As a tentative measure, one may make paracentesis. If the symptoms improve for a time, one is encouraged to essay the excision of iris.

The Operation.—Narcosis is required only for highly inflamed and sensitive eyes, especially when the patient is shattered from suffering, and for small children. Where there is much softening of the cornea or tremendously high tension, conditions that would make squeezing of the eye dangerous, the blepharostat would better be omitted and the lids held apart by an aid with retractor or fingers. The best form of keratome is a small iridectomy knife, except there be extreme shallowness or obliteration of the anterior chamber, when a narrow Graefe cataract knife is preferable. The incision should be sufficiently peripheral to lie within the vascular zone of the cornea, but its position with regard to the circumference will be determined by circumstances. When blood or pus is to be evacuated, the proper point is downward. In other cases, as in glaucoma from a swollen lens, when it is possible a portion of the iris will have to be incised upward, and so on.

The globe is steadied by fixation forceps, the point of the keratome is made to enter the anterior chamber just as in the incision for iridectomy. When the blade has been pushed far enough, the handle is tilted further backward to avoid wounding the lens during the escape of aqueous, and then turned slowly to one side so that the knife will pry open the cut and drain the anterior chamber. Just here is when the patient is apt to feel the greatest pain, supposedly from the contact of the sensitive iris with the cornea, and is liable to squeeze or move the head. It is for this reason and also to prevent prolapse of the iris, that the aqueous must not be allowed to gush out suddenly. The knife is slowly withdrawn, if need be extending the incision in its exit, as in iridectomy. If the Graefe knife is chosen, the incision is made by puncture and counterpuncture, as in extraction, though, of course, its extent is much less. The section is finished slowly. After this the spatula may be used to pry open the wound or, at least, to depress its posterior lip. If blood or pus is to be evacuated, it may be coagulated and refuse to come out with the aqueous. In this event an injection of 1% warm salt solution by means of one of the syringes for lavage of the anterior

chamber may be used to wash out the clot or curd. If the iris escapes in spite of proper care in making the incision, it can usually be replaced with the spatula. If not, the prolapse must be excised. The eye is bandaged in the regulation way.

A distinctive method of paracentesis is the *incision of Saemisch*,[1] and one that has been extensively employed in the different infectious ulcers of the cornea. The original mode was to make the incision as nearly as possible in the center of the ulcer. Alfred Graefe and Meyhofer taught to make the cut as a tangent to the ulcer and thus slit the infiltrated border, and that in the direction of its greatest progress. Saemisch also came to make it somewhat similarly. Since part of the object of the incision was to drain and relax the infiltrated tissue, as in orbital phlegmon, this would seem rational. A narrow Graefe knife is used; the blade is entered, edge forward, at one extremity of the affected area, and brought out at the other extremity, in its passage being made to open the anterior chamber; *i.e.*, by puncture and counter-puncture. The incision is reopened daily by a small probe or probe-pointed lacrimal knife till the ulcer is no longer a menace. The constant leakage of aqueous is believed to prevent infection of the deeper parts of the eye. Manifestly, the same precautions must be taken against squeezing out of the crystalline, etc., as in other forms of paracentesis. The operation is difficult with the Graefe knife in certain meridians upon deeply set eyes, a difficulty that can be overcome by the use of a small sickle-shaped blade.

Anterior synechia, *leucoma adherens*, and glaucoma, the natural sequels of septic processes in the cornea, not to mention panophthalmitis, are more frequent after paracentesis of any kind has been resorted to in the treatment of kerato-hypopyon.

Paracentesis and Massage in Glaucoma. In cases of chronic or intermittent or irritative glaucoma—in short, in any but the acute idiopathic variety—these are therapeutic measures that cannot be too strongly recommended. They are harmless and cause the patient little inconvenience, yet often effective in the highest degree. The paracentesis should be thorough and very slowly made. Within from 6 to 12 hours afterward the eye is washed outwardly with warm sublimate solution, the contents of the

[1] Ulcus Serpens Cornea und seine Behandlung, Bonn, 1870.

Meibomian canals are greatly expressed, the eye and the entire conjunctival sac are copiously irrigated with warm boric acid solution, and a systematic course of massage is begun. This may be either *direct*, i.e., by a smooth instrument, such as a glass rod with rounded end, applied immediately to the globe; or *indirect*, i.e., by the fingers applied exterior to the lids, the mode accredited to Pagenstecher. I prefer the last. The massage may also be either *plain* or *medicamentous*. The use of myotics in conjunction with the massage is most always indicated. These can be in the form of solution or ointment—simple or combined. The ointment is usually preferable as it clings more tenaciously to the parts chiefly concerned, and, besides, facilitates the massage as a lubricant. Simple pilocarpin muriate or eserin or both together or, to what is probably better, these two combined with cocain. The latter is the *pek* so warmly commended by Wicherkiewicz, who, by the way, has been one of the foremost advocates of this kind of massage. The author has of late used with apparently good results a mixture of eserin, cocain and dionin.

Modus Operandi of Massage.—The same rules here given are applicable to ocular massage in general. Hands and eyes are carefully prepared. The patient sits facing the operator. The work is done with the thumb or with the first finger, which is clad in a delicate rubber cot. Massage of any particular part of the globe, except of the cornea, is made with the patient looking in the opposite direction. Thus, for the upper equatorial region the eyes are rotated far downward, etc. By noting the position of the other eye one knows what part is being rubbed. The upper lid is utilized for the upper half, or rather quadrant, of the bulbus, and the lower for the rest. First, circular movements are made, say in the direction of the hands of a clock. Second, this is reversed. Third, movements in straight lines across, up and down, and diagonally. Fourth —and this is an important movement—by backward strokes, following the meridians of the globe. These are repeated, in regular sequence, over and over. The degree of pressure exerted may vary from very light to pretty firm, owing to the needs of the case, and in accordance with the judgment of the *masseur*. The intervals between sittings are from a few hours to an entire day, as the case demands. The duration of the massage is from two to four minutes for a single eye. By covering each thumb with a cot, both eyes

can be done simultaneously. Anointing of the lids or the thumbs is inadvisable; though sterile vaselin or other ointment or 1% salt or 4% boric acid or other solution should be put into the conjunctival sac. If ointment is employed, one application per sitting is sufficient; if an aqueous solution, two or more instillations are made. Ocular massage, intelligently practised, is a most valuable adjunct in the treatment of most affections of the eye. It is peculiarly precious in diseases dependent upon degenerative changes in the circulatory apparatus, like glaucoma, the so-called albuminuric retinitis, arterial and venous thrombosis of the retina, intraocular hemorrhage, and embolism.[1]

Paracentesis by Galvano-puncture of the Anterior Chamber.—Haberkamp[2] has sought a measure which would be practicable without preparation and which might be done in a consultation room or at the home of the patient. While he claims no originality in the procedure he proposes, he has been unable to find it mentioned in the literature. The method is a paracentesis by galvano-puncture of the anterior chamber—the healing of the puncture being slow, a prolonged effect is had, greater than would be the case from an ordinary paracentesis. Haberkamp reports two cases treated by this method. The first case was cured; in the second the patient was blind from fulminating glaucoma, suffered agonizing pain, and enucleation was at first deemed essential; galvano-puncture stopped the pain and the necessity of removing the eye was done away with.

This, in the opinion of the present writer, would be a delicate undertaking at the hands of one not skilled in the use of the cautery; as overheating of the aqueous, with consequent injury to the iris and the crystalline, could easily be brought about.

Conical Cornea; Keratoconus; Staphyloma Pellucidum.—The first two terms describe the abnormality better than does the third, since it is the shape of the cornea that gives name to the defect without any special reference to its transparency, for in many instances considerable opacity exists. The apex of the cone is seldom at the center, being for the most part situated below the center. Many and varied are the surgical measures that have during the last century been devised relative to this condition. The first

[1] Bjerrum, of Copenhagen, very strongly recommends pression massage, over the center of the cornea only after paracentesis and iridectomy for chronic glaucoma.—*L'Oph. Provinc.*, March, 1909.

[2] La Clinique Ophtalmologique, July 10, 1905.

were directed more to improvement of the vision than to the reduction of the cone. Travers and Tyrrell, for instance, in the second decade of the 18th century, made optical iridectomy, and later Critchett and Bowman attempted to substitute the dangerous operation of iridodesis. The first to institute a procedure for the actual cure of the deformity was Fario,[1] in 1839. He removed a wedge-shaped piece from the summit of the cone, dressed the eye, and allowed the wound to heal without suturing, and declared himself satisfied with the results. Sichel and von Graefe, near the middle of the 19th century, sliced off the tip of the cone, preserving Descemet's membrane, then, after a day or so, touched the spot with mitigated stick. The cautery was regularly applied until healing occurred. After this the tip of the cone was punctured, the aqueous drained, and attempts made to maintain the fistula by subsequent punctures, with the object of still further flattening the cornea. If necessary, an optical iridectomy completed the surgical treatment. Bowman, in 1869, removed the whole thickness of the apex with a trephine of his own invention. He later modified the measure by leaving the posterior layer. Several days thereafter, the floor of the excavation was perforated, and regularly reopened for a period of two or three weeks. Such a procedure could not be applicable where the usual amount of thinning exists at the summit. De Wecker and Warlomont also had their trephines. Bader[2] removed an oval flap from the apex, now stitching the opening with fine silk or silver wire, again leaving it to close of itself. All of these operative processes, while credited with a modicum of success, were, on the whole, both unsatisfactory and hazardous—the last, mainly because of the great reaction, of infection, and of iris complications. No better results followed the method of excising a segment from the base of the cone, tried by Quadri, Roosbroeck, and others. Gayet,[3] to avoid these dangers, practiced cautery of the apex, to perforation. Abadie,[4] to obviate central opacity, moved the cautery from the apex to the more peripheral portions of the zone, respecting the posterior layer. Since the introduction of the thermic (or electric) cautery for this purpose,

[1] Mem. della Med. contemp., 1839.
[2] Lancet, 1872.
[3] Lyon médicale, xxx, 1879.
[4] Thèse de Guiot, 1887.

cauterization of the apex has largely taken the place of excision. The difference in the size of the resulting scar, after excision and cautery, is very slight, particularly if the cautery is, as it should be, limited to a small area. One beauty of the cautery is that it is its own antiseptic. Since Tweedy's[1] report, the weight of opinion is largely in favor of cautery *with* as against that *without* perforation. Knapp[2] indorses perforation. This surgeon has had made a special round tip for burning the cone. This he lays on cold and heats till it perforates. He gives a timely caution as to overheating of the aqueous, consequently of the lens and iris; even cites a case in which he supposes he produced a cataract in this way. This would seem to be another argument in favor of heating the tip before making the contact.

Elschnig,[3] of Munich, has for the past 15 years been an enthusiastic advocate of the galvano-cautery for keratoconus. He believes that one of the essentials of success is the prompt vascularization of the cauterized area, which increases the density and lessens the extent of the resulting cicatrix, and causes greater flattening of the scar. In order to hasten this vascularization he connects the deep eschar at the summit by a more superficial one, running in a broad strip to the nearest portion of the corneal limbus. Because of the eccentric position of the apex in most cases, neither the denser scar nor its bridge-like extension interfere with vision through the normal pupil. If it should so happen that the tip of the cone is central, the profound burn is placed to one side so that the scar will not encroach too much upon the pupil. He considers subsequent iridectomy unneccessary or harmful, though he may afterward tattoo the opacity in such a way as to prevent diffusion. He uses the dull red heat. These measures, if not more potent for good than the older ones, have at least been less productive of harm.

The author believes with Panas that, all things considered, the more conservative measures are the best, except for the extreme cases. These consist in the prolonged use of myotics and the pressure bandage, as advocated by Weber,[4] and Mohr.[5] Continued

[1] Trans. of Oph. Scy. of the U. K. Jan. 28, 1892.
[2] Norris and Oliver, "Diseases of the Eye," p. 825, 1898.
[3] Wiener klinische Rundschau, 1904, 20.
[4] A. S. O., xxii, No. 4, p. 215, 1876.
[5] A. S. O., xxiii, No. 2, p. 180, 1877.

pressure alone is probably the most efficacious of any single means. The writer had occasion a short time since to cause removal of the lenses in a case of high myopia and conicity of the cornea by a series of discissions. The treatment consisted in incising the capsule through puncture at the bass of the cornea—done with a Graefe knife, *the use of atropin*, and bandaging. The duration of treatment for each eye was about six months. There were three discissions in each, a good deal of reaction following the second and third. The ultimate flattening of the corneas was truly remarkable. The best vision with glasses before the operations, etc., was 20/70, both eyes; the best after the year's treatment 20/30+ both. Here the annulment of the myopia, which had been 26 and 24 diopters, would account for most of the added sight, but I attributed much of it to the reduction of the cones. Certainly, thorough trial of the less radical measures should precede any operation that involves special risk. These would be, prolonged wearing of compressive bandage (best netting, put on wet), the cotton of the pad being carefully built on, first filling in the depressions in the lids around the globe, and the dressing renewed daily, when 2 drops of 2% solution of the nitrate or muriate of pilocarpin are instilled. This kept up as long as improvement continues. If no progress is made, repeated paracentesis of the cornea is subjoined, to which might, as an ulterior measure, be added the application of a small galvanic tip, in three or four short meridional lines, near the base. If these measures failed of material improvement, I should still advise against more drastic surgical treatment save where the ectasia is very great and the vision very poor, so poor, indeed, as hardly to be called useful. True, much depends upon the condition of the fellow eye. If this be possessed of fair sight, one may venture further.

Staphyloma of the Cornea. Anterior Staphyloma.—By this term is understood those forms of ectasia of the cornea which develop in consequence of disease, such as ophthalmia neonatorum, accidental wounds, as from the blades of knives and scissors, and surgical operations, such as iridectomy and extraction. The staphyloma is known as total or partial, according as the whole cornea or only a portion of it is involved in the bulging. Blindness is a necessary accomplishment of the total form, not of the partial.

The surgery of total staphyloma dates from ancient times. The Greeks and Romans as early as the Alexandrian period practised ligation for its removal. A needle and thread were run through the center of the base. The thread, which was left double, after being pulled well through, was cut near the needle. Of the two threads thus formed, one was used to ligate each half of the staphyloma. Ætius, early in the Christian era, improved upon this method by employing two needles put through the base at right angles one to the other. Thus, when the double threads were pulled through and cut, four ligatures were made, one for each quarter of the tumor. Ambrose Paré, in the 16th century, in case of a staphyloma that protruded beyond the lids, amputated it bodily. Beer, of Vienna, in 1805, gave a method that, under the name of *abscission*, became classic. By means of his triangular cataract knife he made puncture and counterpuncture in the horizontal meridian at the base of the elongated cornea, directing the edge of the blade forward and downward, cutting out within the base below, then, with the scissors, he made a similar incision upward, completing the abscission. Of course, the lens and part of the vitreous often escaped by the enormous opening. George Critchett,[1] of London, to keep back the contents of the globe after the Beer abscission, first inserted threaded curved needles, convexity backward, from above downward through the ciliary body, about 3 mm. apart, left them projecting from the sclera at either end to serve as bars to the vitreous, etc., while the staphyloma was removed. The needles were then passed on through, leaving the sutures in their places, the last being tied to close the wound. Not liking the idea of passing needles and threads through the sclera, and especially through the ciliary region, Knapp,[2] using fine curved needles, put them through the conjunctiva and superficially into the sclera, as shown in Fig. 216. Beginning just external to the vertical meridian, a little back of the base of the cornea, one needle was put through the conjunctiva and quilted for a distance of 4 or 5 mm. horizontally outward, brought out, carried below the cornea, and passed in the same way, but from without inward. The thread was not drawn down between the two points, but left standing in a long loop. A second suture was

[1] Royal L. O. H. Reports, vol. iv, p. 1, 1863.
[2] Archiv. S. Oph., Bd. xiv, 1, S. 273, 1868.

introduced in the same manner internally. The Beer abscission was then made, the two loops drawn down across the extremities of the wound, and the opposite ends of thread tied. Virtually, the two threads play the rôle of four vertical sutures. De Wecker,[1] modified Knapp's procedure. He first incised the conjunctiva all around the base of the incision, dissected it back somewhat, and put into it a purse-string suture; abscised the corneal ectasis after Beer, and tightened the thread drawing the conjunctiva tightly closed over the opening in the globe. De Wecker, about 1883, wisely concluded to make complete exenteration of the globe before closing the wound.

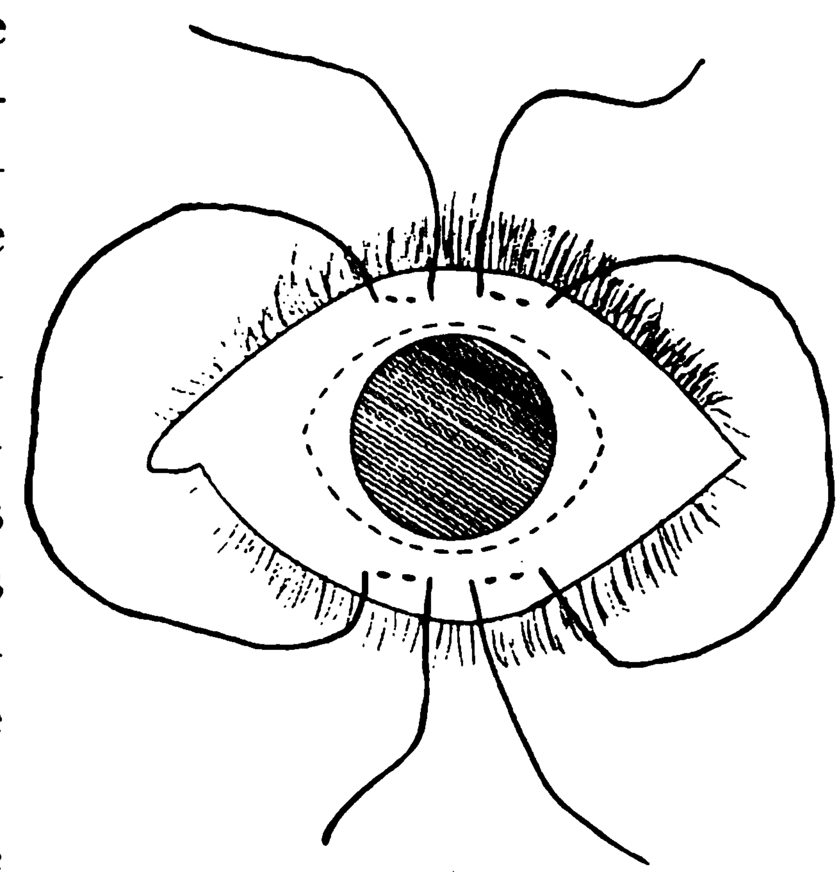


FIG. 216.

Küchler,[2] of Darmstadt, simply incised the staphyloma horizontally, straight through its center, after the manner of his *Querschnitt* for extraction, removed the lens, and allowed the wound to cicatrize.

Such is a brief history of the development of the operation of abscission, for total staphyloma of the cornea, a measure that is now, happily, fast becoming obsolete. Ophthalmic surgeons are beginning to realize the folly of a procedure that only makes the operated eye a greater menace to its fellow. That is to say, the portion which is admitted to be the source of sympathetic inflammation, viz., the uvea, was not only left behind, but left in condition more potent for mischief; that the stump is unsightly without a prothesis, yet that the latter is supported even better after exenteration; that there are three objects for removing a total staphyloma —to correct a deformity, to prevent sympathetic inflammation, and to make a suitable stump over which to wear an artificial eye. The old method fulfilled only the minor indications. Of course, where both eyes are blind it does not matter. When the eye is highly glaucomatous or that of a subject well along in years, expulsive

[1] Ann. d'oculist t. xix, 51, 1873.
[2] Heidelb. med. Ann., vol. vii, 1841.

choroidal hemorrhage is apt to follow ablation. Gradually, therefore, the operation, without exenteration, has lost favor, and the one *with* has found it. Notwithstanding the fact that a number of surgeons still resort to the first form, the writer believes that it has had its day, and deserves no better fate.

Partial staphyloma of the cornea may be anything from (*a*) a tiny bead no larger than a pin-head to a tumor the size of a pea, centrally located, and composed only of Descemet's membrane, translucent or whitish in color, and more or less thickened; or (*b*) a globular mass of varying size, situated somewhat less centrally, composed partly of changed iris tissue, and dark in color in proportion to the amount of pigment or the thinness of the outer covering, and is in full communication with the anterior chamber. Again (*c*) it may occupy the extreme periphery, where it is made up in great part of the iris, is of many sizes, and is connected with the aqueous chamber only by a fistulous tunnel. This is known as cystoid scar. The last two are prone to progressiveness, often reaching enormous proportions—the latter especially; eventually dragging in the ciliary body and other parts of the globe. Hence, it is of the greatest importance that surgical measures be instituted at the earliest possible moment.

(*a*) A touch of the heated cautery tip or a simple incision, with proper rest and bandaging afterward, is usually sufficient for the first class. A very few will be found of sufficient size to oblige the cutting out of an elliptical piece. This is done with cataract knife and iris scissors.

(*b*) Glaucoma is a frequent attendant of the second variety. If the tumor is of incipient size and quite recent, amounting to a simple hernia of the iris, one may be able to mobilize the iris with the spatula, then draw it out somewhat with iris forceps, and snip it off, or to cause its disappearance by one or two applications of the cautery. If the tumor is larger, particularly if the intraocular tension is high, an iridectomy will be required in connection with cautery or incision or abscission, whichever of the three, in the judgment of the operator, is called for. For these more troublesome cases with shallow anterior chambers, a very narrow Graefe knife, one that has been reduced by many sharpenings, will be found invaluable for making the incision to get at the iris; a pair of minia-

ture forceps scissors will sometimes enable one to excise a portion where, by reason of its union with the cornea, it could not be drawn out by forceps in the usual way. How much benefit is derived from the iridectomy and how much from the paracentesis and bandaging, it were impossible to say. No fixed and precise rules can be given for the manner of procedure in these cases—the conditions are too variable.

(*c*) If the cystoid scar has not reached proportions too considerable, it is best to adopt decisive measures while it is yet time. The cyst-like tumor must be freely opened by an incision with a Graefe knife, all of the included iris removed that seems practicable, and what cannot be consistently taken away disconnected as thoroughly as possible from that within the eye. Having cleaned the floor of the cyst, the fistula is sought and touched with the cautery. Bandaging and rest in bed for four or five days complete the cure. If the ectasia has become so great and far-reaching as to make this form of treatment inexpedient, iridectomy, light cautery of the most prominent part of the tumor, the instillation of myotics, prolonged bandaging, offer perhaps the best alternatives. The cautery may be repeated as many times as it would seem to be necessary, and, if done so lightly as not to cause evacuation of the aqueous, it were well to add paracentesis for this purpose. The walls of the staphyloma are commonly of extreme thinness. The effect of cautery is not only to help the iridectomy, the paracentesis and the bandaging in bringing about flattening, but it tends to cause thickening and strengthening of the wall through the building up of connective tissue. The support afforded by snug bandaging, if continued for weeks or months, will of itself cause a deposit of connective tissue that could not occur if the eye were left free.

CORNEAL GRAFTING.

KERATOPLASTY.

True corneal grafting, that is to say, the transplantation of corneal tissue on or in corneal tissue, is of two kinds—tectonic and optic. The first relates to the building up or on of new corneal material to replace that which is lost. For instance, a large pterygium is removed or an area is laid bare in the operation for symblepharon,

and a true corneal graft is put on to prevent recidivation. This has been mentioned in the chapter on Pterygium. The second, or optic, keratoplasty, has reference to that form of grafting whereby an attempt is made to substitute transparent tissue for opaque, and principally concerns those cases where exists blindness from total leucoma.

It is but natural that surgeons should strive, as did Pellier[1] more than a hundred years ago, and as they have striven, at intervals, ever since to put windows into these pitiable eyes. As yet their striving has been mostly in vain in so far as accomplishing the main object is concerned. Surely, though, it will be accomplished. One cannot help being impressed with the probability of this when, as has been the experience of many, one sees a patient with purulent ophthalmia whose cornea has just been completely destroyed by sloughing, yet enabled to count fingers or even to tell the time on a watch, with the afflicted eye by means of a rising button of vitreous. It may have been some such incident that turned Pellier's thoughts toward the possibility of putting in an artificial cornea, and that has actuated certain others since his time, as, for instance, Nussbaum,[2] who inserted a double button of glass in the center of the cornea; and Dimmer,[3] who made similar trial of a celluloid disk. These foreign bodies, although they restored some vision for the moment, either soon came out or were buried beneath the tissues.

Keratoplasty is called *total* when the piece to be replaced and the graft each includes the entire thickness of the cornea, and *partial* when each includes all but the posterior layer.

The first to make an actual attempt at optic corneal grafting was Reisinger,[4] who but acted, however, on the suggestion made to him in 1813 by his friend and teacher, Himly.[5] Reisinger's experiments were upon the eyes of rabbits and by total grafting. His success did not encourage him to continue. Some years later, Muhlbauer,[6] proposed the method of partial keratoplasty, though he did not

[1] Pellier, Manuel de Leféhure sur les ophtalmies, 1802.
[2] Deutsche Klin. No. 34, 1853.
[3] The Operative Treatment of Total Leucoma, etc., Trans. Heideb. Oph. Scy., 1889, S. 147.
[4] Baerische Ann. . . . aus dem Gebiete der Chirurg., etc., 1 Heft, Sulzbach, 1824.
[5] Himly, Krank. und Misshildung. des Aug., S. 60, 1843.
[6] Schmidt's Jahresb., xxxv, 1839.

carry the notion into execution. Desmarres,[1] imbued with the idea of Reisinger, made divers trials of it upon animals. He demonstrated that the grafting of a cornea was possible, but he found that the transplanted portion always lost its transparency, so he abandoned the project. The next to take it up was Power,[2] but chiefly in a theoretic manner. The most determined and serious efforts at optical keratoplasty within recent years were those of von Hippel.[3] Having, like Desmarres, become discouraged by attempts at total keratoplasty, von Hippel finally adopted the method proposed by Muhlbauer, just alluded to, viz., that of partial keratoplasty, and devised an ingenious trephine for cutting both the cornea to be replaced and the graft. He found that while a total graft would become opaque in 2 or 3 weeks, the partial would remain transparent for a much longer time. Knapp[4] relates having seen a patient presented by von Hippel at the 1887 meeting of the Heidelberg Ophthalmologic Society, on whom he had made such a keratoplasty more than a year previously. "The piece was still tolerably transparent, and the patient had useful sight." The ultimate fate of the best results so far obtained has been loss of the restored sight through clouding of the graft.

It goes without saying that the operation is not to be thought of in any case where vision can be restored by any other known means, such as iridectomy. Seeing that the Descemet's membrane and even the deepest portion of the corneal tissue proper must be transparent, the cases to which the method is applicable are rare. The graft may be made in any available part of the cornea. If the iris should be in the way of vision it should be excised.

The operation of partial keratoplasty after von Hippel is briefly as follows: Local anesthesia. First, one makes an estimate as to the thickness of the leucoma. This is done by lightly pressing upon it with a blunt stylet, and testing the degree of resistance. Usually the trepan would be set to cut the depth of about 0.75 mm. The diameter of the disk should not exceed 4.5 mm. The eye is steadied, and the trephine, which works automatically by a spring, is made to cut to the indicated depth. The instrument is removed, and, with

[1] Ann. d'oculist, 1843.
[2] Trans. London Congress, 1873, pp. 189–194.
[3] A. S. A., xxiii, 2, S. 79, 1887; xxiv, 2, S. 335; xxiv, 1, S. 108, 1888.
[4] Norris and Oliver's System, 1898, p. 832.

delicate forceps and knife, the upper layers of the outlined portion carefully dissected out, leaving a flat, transparent bottom to the excavation. A young rabbit is chloroformed, the trephine is set for 1.5 to 2 mm. (for here the whole thickness is removed), the graft is excised, and quickly transferred to its destined place. The eye is closed and bandaged. No sutures are used.

Zirm modified this operation in 1905 by using a graft from a human cornea instead of from that of a rabbit. The trephine is used as in the von Hippel method. Eserin is instilled if the anterior chamber is present. Zirm gives, as essentials for the successful performance of the operation, deep anesthesia, strict asepsis, the avoidance of antiseptics, and the protection of the graft between two pieces of gauze, moistened with sterile physiologic salt solution, and keeping it warm in steam until it can be placed in position. The graft is held in position by two conjunctival sutures which pass over it in such a way as to form a St. Andrew's cross at the center. In the case reported the patient, a man 45 years old, had 5/50 vision; 5/20 with a convex lens, and J 13, seven months after the operation.

TATTOOAGE OF THE CORNEA.

The staining of the cornea in cases of leucoma, partial or total, is of ancient origin. Galen practiced cauterizing the surface with a red-hot stylet and afterward rubbing into the raw area powdered nut-galls mixed with iron or a mixture of powered pomegranate bark and a salt of copper. The first to make use of tattooage proper, i.e., with a needle and India ink, which is the most approved substance, was Taylor, the noted English quack oculist, near the middle of the 18th century. At first the ink was put into a cannula, inside of which the needle was worked. It is, however, to De Wecker[1] that we are mainly indebted for a distinctive method and largely also for the technic of the modern operation.

The object of tattooage is either optic or cosmetic. The indications for optic tattooing would be found in such cases as aniridia, albinism, coloboma of the iris, and in diffuse nebulosities of the cornea—the last in order to make the vision more net. In these

[1]Union méd., mars, 1870, and Chirurg. oculaire, p. 181.

conditions, of course, the area of the cornea corresponding to the pupil would be left clear, and the pigment made to occupy the peripheral zone. In this way the photophobia would be lessened and the visual acuity increased. The sphere of cosmetic tattooage is limited to the hiding, or rendering less conspicuous, of opacities of the cornea. Both kinds can be made to serve useful ends, for, even as to the second, it is an indisputable fact that little blemishes of face and figure constitute a decided handicap in the great bread-winning race as regards both male and female.

The method of procedure is the same in both kinds of tattooage. The instruments are blepharostat, fixation forceps with broad jaws and no teeth, one instrument containing four needles in a compact bundle for work in a circumscribed area, one with four needles in a row for broader areas, and a tiny curved spatula for applying the ink to the surface to be tattooed (Plate II, Nos. 24 and 25). The needles must be quite sharp. The best grade of India or Chinese ink, in cake, is appropriate for all cases, excepting where hazels and browns are to be simulated; for these admixtures of sepia of vermilion and ultramarine are required. A piece is cut or broken from the cake and sterilized by baking for half an hour at a temperature of 150°. It is then taken in sterile forceps or crayon-holder, dipped in water or, what is probably better, a solution of gum-arabic, and rubbed in the bottom of a paint saucer, dipping occasionally for a fresh drop of the liquid, till a few drops of a thin black paste are obtained. If done rightly, this process is tedious. The finer the subdivision of the particles, the better. Of course, the ink must be used as soon as prepared. The colored pigments may be procured in fine powder, then washed, first in water, then in alcohol, then in ether; evaporated in a sand-bath and, lastly sterilized as above, and mixed with aseptic gum-arabic solution.

Technic of the Operation. Local Anesthesia.—After washing the conjunctival sac with boric acid solution, the cornea is dried with the tip of a small cotton sponge from which the moisture has been well wrung. Some operators prefer to mark the pupillary area with the edge of a sharp cylinder and to remove the epithelium within the circle before applying the pigment, but this is unnecessary. A drop of the ink the size of a pinhead is taken up with the spatula and deposited exactly on the spot to be tattooed. If the area is small,

with the bunched needles one pricks the spot through the mass of ink. The needles are jabbed in both perpendicularly and obliquely, and until the color is sufficiently dense. The aim is to get the ink deep in the corneal substance without perforating. If rather free bleeding occurs, it may be stopped for a time by adrenalin solution—else the operation should be postponed. Indeed, a single sitting never suffices for an effective and lasting result; from three to five or even more being required, with a week's interval between. It has been estimated that from 100 to 120 pricks at a sitting are necessary to obtain a good black pupil, and as many as 2,000 where the leucoma is large and the peripheral portion is made to simulate the iris. One should practise tattooage on fresh pigs' eyes, then examine sections of the cornea microscopically, in order to get an idea as to the proper force one should impart to the strokes of the needle instrument. Considerable judgment and skill are needed to do the thing right. If one is uncertain of his hand in the matter, he should confine the maneuver to the slanting strokes. Every little while the pricking must be stopped while the cornea is wiped clean and warm boric or salt solution is gently poured over it, and note made of the effects—distribution of the pigment, etc. Throughout, an assistant keeps the lower conjunctival fornix free from fluid, but sponges the cornea only at the surgeon's bidding. Most surgeons recommend using the needles on the bare cornea, that is, before applying the ink, then rubbing the latter in with the *finger*. While I have no exact data to prove the assertion, it but stands to reason that a greater quantity of pigment can be driven into the cornea by piercing it through the mass of finely divided ink than could be rubbed in. There can be no harm in rubbing, however, but let it be by the back of a tiny spoon or the like--not in this primitive and unsurgical manner with the finger. The ink and the slightly fibrinous exudation from the cornea form a sort of pseudomembrane that rather resists one's efforts to wipe it off. I fancy that this, by the entanglement of the pigment, tends to prevent the needles from driving it in; hence, another reason for frequent pauses and cleansing of the cornea. The eye is bandaged and the patient cautioned to remain very quiet for forty-eight hours. The reaction is usually slight. Armaignac,[1] of Bordeaux, employs

[1] Receuil d'opht., Aug., 1903.

dome-shaped metal shields with various-sized circular openings at the top as guides to tattooage—those with the smaller perforations are for doing the pupillary area, those with the larger for the iris zone. The shield is held firmly on the globe while, with a four-needle instrument, the exposed space is rapidly pricked.

The operation of tattooage has been decried by some because of a supposed tendency to produce sympathetic ophthalmia. I cannot see any reason for its being a dangerous procedure. It must be remembered that eyes that are afflicted with leucoma of the cornea are prone to inflammations and degenerative changes that sometimes lead to sympathetic trouble. It were well, then, for his own peace of mind, if nothing more, that the surgeon exercise discretion in selecting cases for tattooage. The eye should be absolutely quiet, the globe in nowise atrophied, free from partial staphyloma, any extensive adhesions between iris and cornea, and from septic disease of the conjunctiva and lacrimal canal.

Anatomic investigation of tattooed cornea by Alt,[1] Browicz,[2] Hirschberg,[3] and others have shown that the particles of carbon which at first occupy the needle punctures almost immediately begin a slow migration, which probably never entirely ceases. After some months or a year, they are found sparsely among the deepest layers of epithelial cells, but their chief abiding place is in the anterior half of the stroma, being thickest in the layer immediately beneath Bowman's membrane. They accumulate in the lymph spaces in the form of flakes and balls, while the smaller ones are dispersed among the neighboring structures, some enclosed by the corneal corpuscles and by the fixed and lymphoid cells. They even find their way into the walls and endothelium of the blood vessels. This dispersion, fortunately, is less rapid in proportion as the leucoma is dense, i.e., as the cornea is degenerated.

Only pigments that are insoluble in water are suitable for tattooage, the best being ultramarine, cinnabar, sepia, ochre, and lampblack. Woinow,[4] Vocher,[5] and Hock[6] have written on multicolor tattooage.

[1] Am. Jour. of Ophy., i, p. 8, 1884.
[2] A. S. O., xxiii, 23, S. 212.
[3] A. S. O., xxviii, 1, S. 269. ff, 1882.
[4] Trans. Russian Scy. of Physicians, Moscow, 1872, No. 13.
[5] Bull. et mém de la soc. franç. d'opht., 5 me année, 1887, p. 248.
[6] A. S. A. u. O., 1876, vol. i, S. 90–101.

The Influence of Tattooing of the Cornea on the Visual Acuity.—Dr. Nagoya,[1] Mageda, Japan, reports 30 cases out of 58 in which he had splendid optical results with tattooing of semitransparent maculæ of the cornea with India ink. On three plates he demonstrates by his photographic method very instructively the impairment of vision by maculæ of the cornea and the improvement by tattooing them. With the Zeiss lens "unar" and iris diaphragm of 15 mm. diameter he photographed a diploma. If one-half or the center of the anterior surface of the photographic lens was painted with paste, the photograph was indistinct; if the painted surface was then blackened with India ink the distinctness of the pictures remained uninfluenced.

OPERATIONS UPON THE SCLERA.

As Czermak quite rightly observes, with the exception of the suturing of traumatisms and a few minor operations, such as curettage, etc., all the operations upon the sclera are undertaken not because of any disease or defect of this tunic itself, but for the relief of those incident to one of the other coats or of the entire globe. They are, sclerotomy, anterior and posterior; excision (trephination); galvano-puncture, and suturing.

SCLEROTOMY.

Incision of the sclera, sclerotomia, is of two kinds—anterior and posterior—so named from the situation of the operation with reference to the iris and ciliary body.

Anterior Sclerotomy.—The idea that the efficacy of the operation of iridectomy for glaucoma was due, not so much to the excision of iris as to the scleral incision, seems to have occurred first to De Wecker.[2] About the same time, Stellwag v. Carion, who had formed a similar opinion,[3] mentions that in a case of double glaucoma he made iridectomy upon one eye and merely the incision upon the other, and that the result was equally good in both. The first, however, to systematically practise anterior sclerotomy for glaucoma was Quaglino,[4] who

[1] Beiträge zur Augenheilkunde, 1905, Heft 64, p. 232.
[2] Traité des maladies des yeux. 1867.
[3] Der Intraoculäre Druck, Wein, 1868.
[4] Annali di Ottala., 1871, p. 200.

reported five cases of glaucoma in which he had made the operation, giving favorable results. Quaglino made the incision with a large, triangular keratome, much in the usual way for iridectomy, the only differences being that he began the scleral incision 2 mm. behind the sclero-corneal junction, pushing the blade very slantingly through into the anterior chamber. Then, before withdrawing, he tilted the handle back, and, slightly prying open the cut, allowed the aqueous to run out very slowly, to avoid prolapse of the iris. The same year that Quaglino made his report, De Wecker,[1] gave an account of seven cases of glaucoma in which he made anterior sclerotomy by a new method, which he called "*incision double avec pont sclero-conjunctival.*" This, which has been followed, perhaps, oftener than any other mode of anterior sclerotomy, is as follows: The pupil is, if possible, contracted by eserin, then the eye is lightly cocainized. With a narrow Graefe knife, puncture and counterpuncture are made above 1 mm. back of the limbus, as if for linear extraction with flap 2 mm. high. The knife is carried upward with slow sawing movement until the edge engages well in the angle of the iris, when, instead of cutting out, it is twisted a little on its axis to allow all the aqueous to escape, then withdrawn, leaving undivided a bridge of sclera and conjunctiva, about 3 or 4 mm. wide—or about one-third of the distance between the points of the puncture and counterpuncture. The points claimed for the procedure over the completed incision were freedom from iris complications, staphylomatous scar, loss of vitreous, and relapses.

Wiegman[2] designed a double keratome for making the De Wecker incision.

A Few of the Many Other Modifications.—Panas[3] gave a method of anterior sclerotomy which he called *oulétomie,* specially destined, as its name implies, for incising the cicatrix in cases of relapsing glaucoma after iridectomy, where adhesions and inclusions of the iris had occurred. This consisted in making the usual punctures with very narrow Graefe knife near the ends of the remaining cicatrix, and so completing the section as to include the entangled iris and scleral scar, but left intact a narrow bridge of conjunctiva.

[1] Ann. d'oculist., 1871.
[2] Kl. Mbl. F. A., 1897, p. 277.
[3] Soc. franc. d'opht., 1883.

At times he also divided the latter. De Wecker[1] made a similar operation which was named "cicatrisotomy."

Tailor,[2] under the name "internal sclerotomy," gave a measure, and for the execution thereof Vicentiis[3] designated an instrument consisting of a needle-like shaft, bearing at its extremity a tiny, sharp, sickle-shaped, or slightly curved blade, with the cutting edge on the convex side; blade and shaft being so designed that the latter effectually stops the incision made by the former and prevents the premature escape of aqueous. The blade is passed into the anterior chamber on a level with the horizontal diameter of the cornea, and 15 mm. in front of the limbus, carried across to the other side, where the convex edge is pushed into the angle of the iris; the handle is given a sort of rotary motion, whereby the scleral border of the iris is severed and the sclera itself cut to the depth of about 1 mm.

The Scleriritomy of Nicati.[4]—The very narrow Graefe knife is passed through the anterior chamber *at the bottom*, with its edge in the angle of the iris. When the point is fairly through the conjunctiva on the opposite side, a quick, quarter turn is given the blade, bringing its plane at a right angle to that of the iris, edge backward. The aqueous here escapes, causing the knife to snip into the iris. Now, with a rapid movement, the blade is withdrawn, so manipulating the handle as to incise the root of the iris all the way. Care is taken to pry open the wound with the spatula to allow the blood to escape. The indications given are secondary glaucoma from incarceration of iris, cystoid scar, occlusion of the pupil, and primary senile glaucoma.

Knies[5] gave what he termed "irido-sclerotomy," made, under myosis, by upward section with the Graefe knife, and in such a manner as to divide the root of the iris from the sclera in cutting out—as it were—a sort of iridodialysis. Sometimes a bridge of conjunctiva is left intact. The indications cited are the same as those for iridectomy and anterior sclerotomy in general.

De Wecker's[6] **sclerotomie combinee** has also as principal object the making of artificial iridodialysis. Myosis is produced,

[1] Ann. d'oculiste, xciii, p. 10, 1885.
[2] Annali di Ottal., xx, 1891, p. 117.
[3] Soc. It. d'opht., 14 session, Venise, 1895.
[4] Bull. et mém. de la soc. franç. d'opht., 1892, p. 278.
[5] Vers. der Ophth. Ges. zu Heidelberg, 1893, S. 118.
[6] Annal d'oculist., t. cxii, 1894, p. 201.

where possible, and 1 drop of cocain solution instilled. The incision is made as for ordinary iridectomy, beginning 1 mm. behind the limbus, but with that surgeon's own stop-knife. The aqueous is evacuated slowly. A special forceps is introduced. When the closed jaws are seen 2 mm. from the base of the cornea, they are opened, the iris is caught near the periphery, and the forceps pushed downward, hugging the posterior surface of the cornea, till the iris is torn for a distance of 6 to 8 mm. from its fastening. The forceps is now withdrawn, but in doing so one must not forget that the jaws must be first opened.

Galezowski,[1] too, has furnished a measure—**crucial sclerotomy**—and a special keratome with which to make it. The blade of the instrument is lanceolate, measuring 3 mm. at its greatest width by about 2 centimeters in length, and is slightly curved on the flat. It is put through the anterior chamber twice, convexity toward the iris, so as to incise the sclera at the four cardinal points. Thus is obtained the maximum of severance (12 to 14 mm.), with the minimum of risk. The second passage of the knife can hardly be an easy one.

The alleged indications for anterior sclerotomy are:

(*a*) Glaucoma simplex, especially as a tentative measure.

(*b*) As a preparatory step to iridectomy when T is high and anterior chamber obliterated.

(*c*) Congenital glaucoma, or hydrophthalmus.

(*d*) For relief of pain in hemorrhagic and absolute glaucoma.

(*e*) For relapsing glaucoma after iridectomy.

As a matter of fact, whatever of benefit resulted was probably due to the paracentesis rather than to the character of the incision, and the measure in all its forms has practically been abandoned. Yet there was a time, a few years after De Wecker, with characteristic zeal, took the matter up, that it had a veritable boom, and bade fair to supersede the operation of iridectomy as a cure for glaucoma.

POSTERIOR SCLEROTOMY.

SCLERAL PUNCTION. PARACENTESIS SCLERÆ.

Incisions of the posterior segment of the sclera were made early in the century, James Ware, of London, having practised it for

[1] Congr. de chir., Paris, 1898, p. 175.

detachment of the retina. Later, Sichel, v. Arlt, and De Wecker resorted to it in the same connection. Punction of the sclera had been done also for general staphyloma of the globe. The first, however, to employ the operation for hydrophthalmus and glaucoma was William MacKenzie, of Glasgow, about the year 1830. He made the operation with a lance knife, choosing as the site about the same part of the sclera in which the old scleronyxis was made for couching. After piercing the vitreous, the knife was slightly turned to pry open the wound. It fell into disuse for the diseases in question, to be revived by de Luca,[1] who, it seems, was ignorant of MacKenzie's use of it. De Luca made the incision, not only in blind eyes, to relieve pain, but in those that still possessed vision.

The simplest method for posterior sclerotomy and the one commonly chosen is as follows: The eye is cocainized. The patient is made to rotate the eye far up and in; the globe is steadied by grasping with fixation forceps the conjunctiva near the inferotemporal quadrant of the cornea. A point is sought between the tendons of the external and inferior rectus muscles and at least 15 millimeters back of the corneal limbus, that is free from the larger conjunctival and scleral vessels. Here a Graefe knife is inserted to the depth of 5 or 6 mm., perpendicular to the center of the globe, with its edge directed forward, and by a gentle sawing movement, a meridional incision, some 5 or 6 mm. in length is made. Before withdrawing the knife it is slightly turned on its axis to pry open the cut. A bleb of conjunctiva arising tells of the escape of the contents of the globe, and gives an idea as to the quantity. The knife is removed and the eye washed and bandaged.

While the technic of the operation is simple, yet it is by no means a measure to be slighted. Among the things to be avoided are wounding of the larger blood-vessels of the conjunctiva, Tenon's capsule and sclera (vasa vorticosa), carrying the incision too far forward, i.e., into the ciliary body, pressure upon the globe after the incision is made, either by the surgeon with fixation forceps or by the patient with the orbicularis, and needless wounding of the vitreous. To avoid squeezing, the lids would better be held apart by an assistant with retractors.

Modifications.—In order the more surely to obtain a filtration

[1] Annali di Ottal., ii, 1872, p. 155.

cicatrix and to protect the scleral wound, Baudry[1] recommends drawing the conjunctiva to one side before making the incision, so that the two wounds will not coincide. To prevent too rapid healing of the incision, Parinaud,[2] after making the meridional incision, before withdrawing, gives to the blade a quarter turn and makes a V-shaped scleral wound. For the same reason, Terson,[3] on completing the usual incision, withdraws the knife and makes an equatorial incision, the whole wound thus taking the form of a T.

Others, again, either as a curative or a tentative measure in glaucoma, have practised the sclerotomy without the retinotomy and the choroidotomy. Masselon,[4] made a long, meridional incision of the sclera alone, by using an extremely narrow Graefe knife, passing it through by puncture and counterpuncture from before backward. Later, he added a very small equatorial incision. Simi,[5] and Galezowski,[6] made similar incisions, the latter using for the purpose a knife of his own invention.

The writer, in cases of glaucoma where the eye still has useful sight, and there is great tension, absence of anterior chamber, and, especially, if there is likelihood of expulsive choroidal hemorrhage from an iridectomy, would advise making the posterior sclerotomy between the *internal* and inferior rectus muscles. In this way, any resulting accident at the site of the puncture, within the globe, such as hemorrhage, detachment of the retina, edema, etc., are further removed from the macula. To favor greater precision, the overlying membranes are first incised. They are then retracted by two Stevens squint hooks. After the sclerotomy, the membranes are carefully arranged, but no suturing is done.

The indications for posterior sclerotomy are:

1. (*a*) In chronic (simple) glaucoma, with approaching blindness, and other operative measures and forms of treatment have availed nothing.

(*b*) In absolute glaucoma, for relief of pain, or for quieting the eye in cases where enucleation is not practicable.

[1] Technique Operatoire, 1902, p. 639.
[2] Arch. d'opht., v, 1885, p. 180.
[3] Midi. médical, du 8 oct., 1892.
[4] Ann. d'ocul., t. xcv, p. 231, 1886.
[5] Boll d'ocul., ix, 3, 1887.
[6] Seventh Internat. Oph. Congress, Heidelberg, 1888.

(*c*) In irritative primary or secondary glaucoma, with absence of anterior chamber, excessive tension, etc., either as a preliminary to iridectomy or as a last or only surgical resort for relief.

2. In detachment of the retina.

3. In hemophthalmia, especially where the blood is in considerable quantity and is causing high tension, or organization of the clot is feared.

4. In abscess of the vitreous, as in panophthalmitis, when one wishes to avoid enucleation or exenteration.

5. In cases of foreign bodies or cysticercus in the vitreous chamber, to give access for their removal.

6. In total ectasia of the sclera, in lieu of a more radical measure.

Cyclodialysis.—Heine, first assistant in the clinic of Professor Uhthoff, of Breslau,[1] actuated by the idea conveyed in the observations of Fuchs and Axenfeld, relative to detachment of the choroid, following incisions affecting the sinus of the anterior chamber, has proposed a new operation for glaucoma. Fuchs had remarked upon the relative frequency of such detachment after all operations wherein the outer limits of the chamber were incised; and Axenfeld declared that it occurred in as many as 10% when the interference had been for glaucoma. In consequence, these clinicians were led to believe it possible that both the detachment and the beneficial results of the glaucoma operation were caused by the loosening of the choroid from the sclera incident to the making of the incision. Thereupon Heine imagined the surgical measure for glaucoma which he calls *cyclodialysis*, and which consists in an attempt to establish a lasting communication between the anterior chamber and the suprachoroidal space. Heine proceeded to try the measure upon 20 glaucomatous eyes that were totally blind or nearly so. These experiments demonstrated to his satisfaction that the effect of the procedure was to permanently reduce the tension, even in cases of absolute glaucoma. Briefly, the operation may be thus described: A triangular flap of conjunctiva 8 or 9 mm. high is fashioned, downward and outward, with its base left attached at the limbus. A suture is put into the apex and the flap turned down over the cornea. The episcleral tissue in the exposed triangle is scraped

[1] Deutsche med. Woch., No. 21, p. 824.

away. With a small bent lance or a Graefe cataract knife a 2 or 3 mm. long incision is made in the sclera, 4 or 5 mm. from, and parallel with, the limbus, directing the point of the knife, if it be the lance, toward the chamber angle, but not entering it. Meller[1] advises making the cut not with the point of the lance, but with one of its lateral edges, so that more nearly the same depth can be maintained along the whole extent of the wound. A narrow spatula, similar to that used in replacing the iris, only with five transverse lines on its concave surface marking the 5 terminal mm. of the blade, is introduced at the wound. About when the fourth mark is entering, the resistance of the ligamentum pectinatum is felt. After this is slowly pierced, the spatula is visible in the anterior chamber. By lateral excursions this cyclodialysis is enlarged 2 to 3 mm. No aqueous escapes if the instrument is slowly extracted. If, however, an evacuation of some aqueous is desired, the spatula may be pressed toward the globe or a little twisted to pry open the wound. Finally, the suture is tied. Tension is the same after the operation if no aqueous escaped and diminished after two to three days. After escape of aqueous tension is at once diminished. In certain cases it would certainly seem advisable to let out a part of the aqueous and reduce the tension at once, and also follow the operation by the use of miotics, so as to draw the root of the iris away from the angle of the anterior chamber and thus augment the effect of the operation.

Indications for Cyclodialysis:

1. In secondary glaucoma, especially with anterior synechia due to wounds, ulcers or cataract extraction.

2. In glaucoma where the other eye has been lost by severe hemorrhage following iridectomy.

3. In the aged or infirm where it is considered dangerous to keep the patient in bed as in iridectomy.

4. As a preliminary operation where iridectomy is dangerous on account of very high tension, no anterior chamber, atrophic iris and wide pupil, as it lowers the tension, and there is no danger of striking the lens during its performance.

5. When the lens has been dislocated and fallen into the vitreous

[1] Ophthalmic Surgery, 1908, p. 201.

chamber. Iridectomy, for the secondary glaucoma of such cases, is not feasible because of the certainty of losing vitreous.

Contraindications.

Seclusio pupillæ, iris bombé, sarcoma of the choroid, or active iritis.

Accidents and Complications. Immediate.

1. Failure to cut all of the scleral fibres. The spatula will then go only about 1 mm. forward.
2. Hemorrhage from cyclon or scleral vessels or ciliary vein.
3. Running of spatula into a good scleral spur.
4. Detachment of Descemet's membrane from the corneal stroma, indicated by corneal cloudiness.
5. Iridodialysis--which is infrequent.
6. Hemorrhage from Schlem's canal, as its inner wall is formed by the ligamentum pectinatum and the fibres of the ligament are broken and split up.

Consecutive Accidents.—While the operation is of too recent origin to permit one to judge as to its remote effects, tumors, which are apparently implantation cysts, have been observed to occur at the seat of the operation as early as a few weeks after its performance. Two such cases have been seen by the writer.

Results of Cyclodialysis.—Lowering of tension—immediate if aqueous is permitted to escape, gradual if the aqueous is not allowed to escape, so that the maximum effect is not produced until from one to three days after the operation. These results may be permanent or of only a few days' duration. In some cases, especially in absolute glaucoma, there is no improvement at any time. It is not known in just what way these results are produced, whether by establishing an outflow through the perichoroidal space or through the canal of Schlem. It seems probable, however, that the good results which occasionally follow this procedure are due to freeing the angle of the anterior chamber, and not to permanent choroidal detachment.

Excision and Trephination of the Sclera. Sclerectomy.—Removal of a portion of the sclera was first undertaken for cystoid scars or staphyloma consequent upon penetrating wounds.

Coccius,[1] transfixed the center of the tumor with a fine Graefe knife, cutting out parallel with the base, held the lips of the incision closed with a tenaculum, and completed the excision with forceps and scissors. More recently, in a smilar case, Fage[2] incised the overlying conjunctiva, put three catgut sutures through the base of the ectasia, made the exsection, as did Coccius, and then tied the sutures. The loss of vitreous was slight, and the result satisfactory. The idea of first placing the sutures was taken from the Critchett operation for corneal staphyloma. Taylor, Argyll-Robertson and De Wecker, tried trephining the sclera in absolute glaucoma, but have had few imitators. In this connection, however, it may be mentioned that Fröhlich,[3] of Berlin, reports that, in four out of five eyes with absolute glaucoma, and that were as hard as stone, he had succeeded, by trephination, in reducing the tension to normal or subnormal, ridding them entirely of inflammation, and in permanently relieving them of pain. He proceeds thus: Cocain; incision of conjunctiva along lower border of externus, and along outer border of inferioris, extending nearly to cornea, where they are joined. The flap is raised and turned back toward the equator. Von Hippel's trephine, with 5 mm. crown, set for the thickness of sclera only, is used for the excision. On removal of the disk, if retina and choroid are not sufficiently ruptured by vitreous, they may be punctured. The conjunctival flap is put in place and sutured. The scleral wound takes care of itself.

Of late years sclerectomy has been mainly employed in detachment of the retina, the object being to shrink the walls of the globe upon the already shrunken vitreous. Parinaud,[4] put a needle, tangent, into the outer portion of the sclera over the center of the detachment, and lifted up a cone. Through this, and parallel with its base, he passed a Graefe knife so as to excise an ovoid piece 4 or 5 mm. in diameter. The choroid should not be injured. The choroid could be punctured afterward, and, if need be, the puncture repeated after 7 or 8 days.

A bold and extensive operation of sclerectomy for detachment

[1] Heilanstalt für arme Augenkranke zu Leipzig, 1870, S. 35–36.
[2] Gaz. des hôp. de Toulouse, 1894, 18 août.
[3] Kl. Mbl. f. A., Mai, 1904.
[4] Bull. de la soc. franç., d'opht., 1884, p. 77.

outward is that resorted to by L. Müller.[1] The patient was narcotized. Temporary resection of the outer wall of the orbit by Krönlein's method. Excision of the orbital periosteum, exposure of the external rectus, and the inferior oblique, and their severance from the globe. Excision of a strip of sclera 10 *mm. wide by* 20 *mm. long*, extending from 2 mm. behind the attachment of the externus to the posterior pole. Five silk sutures inserted, *and all without the slighest injury to the choroid.* The choroid was punctured and the threads tied. When the subretinal fluid ran out. The retina immediately became reattached, the field of vision became normal except for a small central scotoma, and the sight, which had been reduced to counting fingers in lower field, rose to fingers at 3 meters.

Galvano-puncture has been tried by De Wecker and others, both for detachment of the retina and for circumscribed staphylomas of the sclera, but the results have not been encouraging.

SUTURING SCLERAL WOUNDS.

Small wounds, and even pretty extensive ones that are meridional, may often be left without sutures, simply cleansed, extruding vitreous snipped off, and the conjunctiva stitched over them. But if the scleral wound inclines to gape, it should be sutured. If the scleral and the conjunctival wounds correspond, the same threads may include both; if they do not, it is best to close the scleral opening with absorbable sutures and the conjunctival with silk. Indeed, it is usually deemed best to see to it that the two openings do not correspond, even if a piece of the conjunctiva constituting one lip of the wound must be excised to avoid coincidence. The wound is not only freed from dirt and vitreous, but from shreds of choroid and retina, should these be present. Double-armed, interrupted sutures are preferable, so that the needle can be introduced from within on both sides. The thread should, if possible, be made to include only the outer layers of the sclera, and in no case should the uvea and retina be included either in the wound or in the sutures. The thread or gut should be very fine and the needles of exceptional sharpness.

[1] Wiener kl. Woch., Apr., 1903.

Fage,[1] gives the following reasons for suturing scleral wounds:

1. The prevention of deep infection.
2. Holding back the contents of the globe.
3. The avoidance of fistula, cystoid scar, and staphyloma.
4. The resulting scar is more regular, less contracted, and conduces less to detachment of the retina.
5. The healing process is shortened.

Czermak[2] makes a rule of suturing all scleral wounds that exceed 5 mm. in length. Even the subconjunctival ruptures are sought out, trimmed up, and sutured. If the lens has escaped beneath the conjunctiva, of course it is let out.

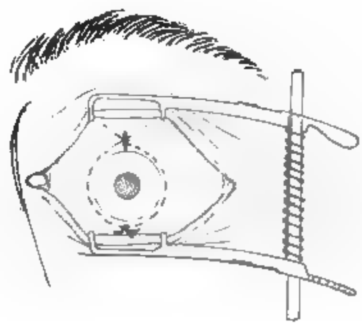


FIG 217.

Nüel[3] has contrived a most ingenious and effective arrangement of the thread for closing corneo-scleral ruptures, as well as for the wound left after the removal of a cystoid scar in that locality. The suture is double armed. One needle is quilted into the sub-conjunctival tissue for a distance of 2 centimeters at, and parallel with, the equator, i.e., for a distance of 1 centimeter on either side of the meridian of the wound. The threads are then crossed over the center of the wound, and each needle carried beneath the conjunctiva, in the episclera, close to, and half-way around the cornea, where they are brought out together and tied (Fig. 217).

EXENTERATION OF THE SCLERA.

(EVISERATIO BULBI.)

Seeing that this operation consists in making an opening in the front wall of the globe and the removal of its entire contents, the author has taken the liberty of classing it among the operations upon the sclera. In this way it can better be kept distinct from the operation of simple incision of all the tunics of the globe; that has

[1] Ann d'ocul, cxii, p 262, 1894.
[2] Augenärztlichen Operationen, p. 690
[3] Ann. d'ocul., xcix, 1888, p 270.

been commonly called evisceration. Indeed, it would be better if the term *evisceration* were dropped from the medical dictionaries altogether, since it has precisely the same etymologic significance as *exenteration*, and is the preferable word in *common* parlance, where *exenteration* is rare.

About a century ago, Wardrop, of Edinburgh, as a cure for the sympathetic ophthalmia of horses, advised incision of the cornea of the exciting eye, and the removal of the lens and vitreous, suggesting at the same time that a similar procedure might be applied to the human eye. The first to put the suggestion into effect was Barton,[1] who employed it for the removal of fragments of copper from the eye. As has already been stated on page 391, De Wecker, about 1883, added exenteration to his tobacco-pouch modification of Critchett's ablation. Fröhlich,[2] in 1881, "removed the front section of the globe and scooped out the contents of the scleral capsule," with the hope of escaping the grave consequences that sometimes follow enucleation. Alfred Graefe[3] adopted exenteration for most cases for which formerly enucleation had been practiced. He excepted those in which there was, or threatened soon to be, sympathetic ophthalmia. This surgeon was the first to plan for the operation a definite technic, the main points of which are as follows: The upper lid is held up by an assistant with a Desmarres retractor. Supposing it to be the right eye, the operator grasps the conjunctiva at the external corneal limbus with fixation forceps, while the assistant does the same only 5 mm. further back in the horizontal meridian. The intervening tissue is put upon the stretch, but without pressure upon the globe, and with a convex scalpel a small vertical incision is made, close up to the forward forceps, carefully carried in until the blackness of the ciliary body shows. Now, with delicate, blunt-pointed scissors, the incision is extended between the sclera and the cornea till the two meet at the corresponding point on the opposite side. Here Bunge's exenteration curet is inserted between sclera and uvea, convex side out, and the two tunics separated, cutting in succession the vorticose veins, the ciliary arteries and nerves, and finally the neck of the optic nerve-head. Having seen that only the bare sclera remains, the cavity is

[1] Crampton Med. Gaz., London, 1837.
[2] Klin. Mbl. F. S., 1881, S. 30.
[3] Tagb. der 57. Vers. Deutsch. Naturf. u. Aerzte, Magdeburg, 1884.

washed and the opening closed by from 3 to 5 vertical sutures that include both conjunctiva and sclera.

The reaction after this operation is usually considerable, the chief features being chemosis, particularly of the lower half of the conjunctiva, and swelling of the upper lid. The chemotic membrane often projects beyond the palpebral fissure, and is very slow to disappear. There is, moreover, needless sacrifice of the outer wall of the sclera. To obviate this, Gifford, of Omaha, quite properly, omitted excision of the cornea, making the exenteration through a simple horizontal incision, thus causing less reaction, and securing a more ample stump.

The writer, who had previously made only the De Wecker operation (described in chapter on Anterior Staphyloma), seeing the advantages of Gifford's method, adopted it. He had noticed, however, that the stump, after all methods where the long axis of the wound lay in the horizontal meridian, was always characterized by a deep cleft, lying in the same direction and reaching far back into the sclera on both sides—really a folding of the globe upon itself, causing it to resemble a grain of barley. This determined him to make the opening vertical, though still, like Gifford, without the excision of cornea, except in cases of anterior staphyloma, when just enough is removed to cause adequate flattening. A long, narrow, vertical, pointed ellipse is ample for even a pronounced staphyloma. In either case, the ends of the incision or the points of the ellipse are extended sufficiently far into the ciliary region to give ingress for instruments and small spindle-shaped cotton sponges. The operator grasps the center of the wound on one side with fixation forceps (without catch); an assistant does the same on the other, and in such a way that, by rotating the instruments, the cornea and sclera can be rolled back like the turning up of a sleeve (Fig. 218). A knife of special design, first described in the *Ophthalmic Record*, July, 1905, is used to dissect the choroid from the sclera (Plate II, No. 39). The blade, ***which is not oversharp***, is double-edged, curved on the flat so as to fit into the scleral cavity, and has a rounded extremity. This serves to sever the roots of the iris, the ciliary body, the veins, arteries, and nerves, but for fear of perforating with the knife when it comes to the optic nerve the assistant takes both forceps, the surgeon holds choroid and retina

with broad-jawed forceps, and cuts the tissues at the limina cribrosa with small, curved, blunt pointed scissors, which completes the exenteration. Copious irrigation of the cavity with hot sublimate

FIG. 218.

solution, 1 : 2000, is now used, for the double purpose of checking the hemorrhage, so that one may see that every vestige of the contents has been removed, and of antisepsis. Any relics of the uvea

are scraped away with the knife or sharp curet. A small flattish curet with finely serrated edge is best. Having been assured that nothing is left behind, the opening is immediately closed by several horizontal silk sutures, allowing the oozing blood to fill the scleral capsule if it will. No attempt is made to stop the moderate oozing of blood, but rather it is encouraged, by mild curetment if necessary, so as to insure a clot of sufficient size to fill the scleral capsule, with the view to its becoming organized, thus adding to the efficiency of the stump. The eye is bandaged in the usual way. For some reason there seems to be even less chemosis following the vertical incision than the horizontal, and the cleft, just alluded to, does not ensue. In case after case the parts involved have remained absolutely quiet. The sutures are removed after 3 or 4 days. Union is usually by first intention. If it is not, a small round hole may appear, which slowly closes. I have never seen any harm come of it.

There is pretty free bleeding while the separation of the choroid is going on, but it does not materially interfere. Of course, the lens and the vitreous escape as soon as the globe is well open.

Exenteration is *indicated* in all instances where it has been the custom to make enucleation, save where exists sympathetic ophthalmia, a neoplasm of the globe, or phthistis so advanced that only a tiny, shapeless button remains. I would not even except those in which sympathetic trouble is impending, nor would I those in which it is already present but for the popular prejudice of the profession. Yet more, I would, and *do*, add all the cases of total staphyloma of the cornea. For, as before stated, ablation of the staphyloma fulfills none of the indications, or, if any, does it poorly, while exenteration meets them all and meets them well. For all but the cases mentioned as exceptions, it is not only a much better procedure than enucleation, in view of the objects desired, but all the evidence points to its being a safer one. All those parts that have been deemed a menace to the fellow eye are as effectually gotten rid of as by enucleation. As to the growth of new nerve structures within the exenterated sclera, discovered by Forget,[1] and mentioned as a possible source of discomfort, if not of danger, it would seem quite as easy for this to occur within the capsular envelope which remains after enucleation. As to the conditions for the wearing of

[1] Arch. d'opht., t. xii, 1892, p. 693.

a prothesis, they are vastly more favorable where the walls of the globe are left intact than where they have been taken away entirely. Made according to the principles just given, there being no inflammatory reaction, not only is an extra large stump afforded for filling out the orbit and giving to the artificial shell something like suitable prominence, but the muscles are all left with their original attachments, and in their normal relations, so that its movements are reasonably extensive and natural.

The Substitution of an Artificial Vitreous Body.—In spite of the greatest care *in*, and of only a minimum of reaction *after*, the operation of exenteration, the shrinkage of the stump becomes, in time, considerable, and, in consequence, its motility becomes much restricted. With the view to supplying a larger and more movable permanent stump, Mules,[1] of Glasgow, conceived the idea of placing in the exenterated sclera a hollow glass ball. Encouraged by the immediate results of the procedure, ophthalmic surgeons everywhere followed Mules' example, and a few became enthusiastic over it. After a few years, however, even those who had in the beginning been most captivated grew less ardent. Too often the ball refused to remain imprisoned. The measure was mostly abandoned. Some, who had been won by the really great plausibility of the method, began to cast about for spheres of different substances and of different construction. Kuhnt, for example, tried silver; Keal, gold; Bryant (of Omaha), fenestrated aluminum, etc. The material that seems, at the present time, to promise most in this connection, is paraffin. Living tissue will bear incorporation with this substance more tolerantly than with any other thus far introduced. There are two ways of filling the sclera with paraffin: 1. By closing the opening in the globe and overlying membranes by a common purse-string suture, or by suturing them separately; then injecting into the scleral cavity the melted paraffin. This is the method of Brockaert, also that very successfully followed by Ramsay, of Glasgow. 2. By fashioning the sphere of hard paraffin beforehand, and inserting it in the cavity after the same manner in which Mules employed the original ball of glass. This is the mode recommended by Oatman, of New York, and is probably the more desirable as to precision. Balls of paraffin having a high melting-

[1] Trans. Ophthalmolog Society, 1885, vol. v, p. 200.

point—140 degrees and over—are prepared by fusing, filtering, and sterilizing, then rolling, while yet warm and plastic, with the protection of rubber gloves. In size, they should vary from a diameter of 12 mm. to that of 18 mm., according to the capacity of the sclera they are to occupy. They are kept ready for use in a glass jar filled with a 5% solution of formaldehyd. Before being placed within the sclera, the ball is rinsed with a solution of bichlorid, 1-2000. If the opening in the sclera is sufficiently large, the ball may be put in place with ordinary dressing forceps. Usually, however, it will be found more convenient to introduce it with the aid of the Mules inserter (Plate VIII, No. 89). All bleeding is previously stopped by means of hot bichlorid irrigation. The scleral opening is closed over the sphere in the vertical sense, i.e., by silk sutures, placed *horizontally*. If the conjunctiva has been first incised around the cornea, chromicized catgut is used to close the sclera in the manner just stated. The conjunctival opening is then drawn together in the horizontal sense—or, by interrupted silk sutures placed *vertically*. Purse-string or tobacco-pouch sutures are not admissible. The eye is dressed in the usual way and left for 48 hours before redressing. Not only is the most rigid asepsis necessary, but it is indispensable that the character of the coapted lips of the scleral opening is such as to insure primary union, else the ball will surely be extruded. Whereas, after exenteration without substitution of the artificial vitreous, it matters but little whether the adhesion be prompt or delayed.

Amputation of the Anterior Segment of the Globe.—Guérin, Saint-Ives, and Heister, in the 18th century, advised, when practicable, to remove the front half of the eyeball, instead of making a complete excision of the globe in order to facilitate the wearing of a prothesis. The procedure was considered applicable to cases of malignant tumors confined to the section to be discarded and to total staphyloma of he cornea. The operation consisted in the ablation of the cornea, the iris, and the ciliary zone, leaving intact the insertions of the straight muscles with their capsular coverings. The scleral incision should be started with a cataract knife, and finished with blunt-pointed scissors. The remainder of the uveal tract, with the retina, is then to be curetted out, and the cavity kept packed with antiseptic gauze until healing occurs. If the operation

were done to-day, the scleral opening would doubtless be closed, at least partially, by suturing.

Amputation of the Posterior Segment of the Globe.—Nicati,[1] performs this operation as follows: A horizontal (or vertical) incision is made into the conjunctiva on the inner side of the globe. The internus is seized, divided through its tendon, and guarded by a catgut suture, which is passed through the tendon and the conjunctiva. The capsule is separated above and below and the optic nerve is sectioned in the ordinary manner. The posterior pole of the eyeball is caught by a tenaculum and drawn forward. The obliques are detached from it and it is drawn through the conjunctival opening, after which the posterior portion of the globe is exsected up to the insertions of the rectus muscles. The tendon of the adductor is secured to its stump, and the conjunctival opening is closed. An accumulation of blood behind forces the cornea forward, but this is removed by compression and absorption. Nicati claims that the convalescence is more rapid than after enucleation, and the results are an excellent stump with the conjunctiva and cornea entire. He asserts, also, that sympathetic ophthalmia is avoided, but th s must be open to question, seeing that there is no provision for the removal of the anterior portion of the uvea. Moreover, the operation is difficult, and involves dangers of deep infection not incurred in those previously described.

None of these operations possess that virtue, dear to the heart of the pathologist, of preserving a perfect specimen for the laboratory as does enucleation.

OPERATIONS ON THE IRIS.

IRIDOTOMY—IRITOMY.

This has for its object the making of an opening or pupil in an otherwise imperforate iris by means of a simple incision, and of the several operations made upon this membrane it is the oldest. The idea originated with Thomas Woolhouse,[2] of London, who proposed, in case of loss of sight from posterior synechia, to tear the iris asunder from behind, with a needle entered through the sclera as

[1] Archives d'ophthalmologie, June, 1903.
[2] Expér. de différentes opér. aux yeux, Paris, 1711.

if for couching (scleronyxis). Whether or not he made the operation, is not known. It is known, however, that 17 years later, another English surgeon, and a pupil of Woolhouse, William Cheselden,[1] put the idea of Woolhouse into practice for closure of the pupil in eyes where cataract had been depressed. Heuerman,[2] of Copenhagen, changed the point of entrance to the cornea. Guérin,[3] and Janin,[4] observ'ng that the needle of Cheselden tore, rather than cut, the iris, first made a corneal incision, then made the iridotomy with small curved scissors, one blade of which was pointed and the other blunt. Guérin made a crucial incision in the iris, Janin, a bow-shaped. Maunior,[5] in cases of atresia of the pupil, with atrophy of the iris, thrust the pointed blade of the scissors behind the iris in two places, making a V-shaped incision, base peripheral. The inclosed piece was not excised, but merely allowed to retract. Bowman,[6] of London, who was, from first to last, an advocate of iridotomy, invented scissors whose points served as a keratome, whereby the operation could be accomplished with a single instrument. The operation of iridectomy having, in the meantime, become popularized, it for a time largely superseded that of iridotomy. The latter was again brought forward by von Graefe, in 1869, as an efficient measure for those forlorn cases of closure of the pupil, atrophy of the iris, and flattening of the anterior segment of the globe from iridocystitis following a cataract extraction. Von Graefe at first employed the method of Heuermann. The matter was taken up with a will by ophthalmic surgeons, having been specially pushed by Bowman and De Wecker. The last-mentioned brought to bear all his wonted ingenuity, skill, and industry, refining and elaborating the procedure until he not only evolved for it a system of technic that has remained standard, but devised also kindred measures and the rules governing them for cases not adapted to iridotomy. Conspicuous among these were his *irito-ectomy* and *irito-dialysis*. His labors in this line included the invention of several instruments, the most valuable of which is his forceps-scissors, which embodies the principle of the Liebreich

[1] Philosoph. Transactions, 1728.
[2] Abhandlungen v. d. Chir. Operationen, Kopenhagen, 1756.
[3] Traité sur les mal. des yeux, Lyon, 1769.
[4] Mém. et observations sur l'oeil, Lyon, 1772.
[5] Mém. sur l'oper. de la pupille artif., 1812.
[6] Med. Times and Gazette, 1852, p. 35.

iris forceps, and which, in some form, is still the favorite instrument for all sections of the iris. The corneal incision he made with a stop lance, similar to the paracentesis knife of Desmarres. The advantage of this instrument over the ordinary keratome is that there is no danger of penetrating too deep, or even, as could happen, to the extent of having the entire blade enter the anterior chamber.

De Wecker's Methods of Iridotomy. In cases of occlusion of the pupil, with presence of the crystalline, he made a corneal incision opposite that part of the iris zone where the pupillary border was least adherent. Through this he inserted, closed, the blades of a pair of his scissors, both points of which were blunted. When approaching the pupil, the blades were slightly opened, one of them

FIG. 219. Incisions.

FIG. 220. Result.

passed behind the iris, taking care not to wound the lens capsule, the blades still wider opened and pushed further in, a cut made, the instrument slightly rotated and another cut made, thus loosening a pointed flap, apex inward, like that of Maunior (Figs. 219 and 220). For complete atresia of the iris in aphacic eyes either the point of the keratome, while engaged in the corneal incision, was made to pierce the iris at a suitable spot for inserting the scissors, or else the operator used a pair of scissors, one blade of which was sharp-pointed, and with this the membrane was transfixed. The cut could be single or double.

De Wecker's irito-ectomy and irito-dialysis are applicable only to cases of closure of the pupil where the lens is absent. Irito-ectomy is a combination of iridotomy and iridectomy, or, in other words, intraocular iridectomy. In this operation the corneal incision and the primary incision of the iris are made simultaneously

and with the same knife. Where a relatively small opening in the iris is desired, an iridectomy knife is entered at the limbus toward which the iris is drawn, and a corneal incision made as if for iridectomy, except that the blade is directed backward at such an angle as to make a corresponding cut in the iris close to its periphery. The blunt-pointed forceps-scissors are then put in at one extremity of the wound, one blade passing behind the iris, and a snip is made toward the normal pupil center. The scissors are withdrawn, put in at the other extremity of the corneal wound, and a similar snip made, the two cuts meeting, whereby is completed the excision of a triangle of iris. If a larger iridectomy is wanted, a large, linear, corneal incision, which includes the iris, is made with a Graefe knife near the limbus *opposite* the point toward which the pupil is drawn, and the triangular piece cut, as just described. Here, however, before making the final snip to complete the section, iris forceps is introduced at the other end of the corneal incision for the double purpose of holding the piece for the cut and removing it from the anterior chamber when severed.

In order to facilitate the making of the iris incision when it is made one step with that of the corneal, as soon as the point of the knife is well within the eye it is tilted so as to pry open the cut and evacuate the anterior chamber, which causes the iris to advance close to the cornea.

The advantage of such (scissors) operations is that they insure a minimum of traction on the root of the iris and upon the ciliary body, hence it suffers less traumatism and remains more quiet afterward. This is not true of those iridotomies made with needle or knife alone except in instances where the instrument can be made to *cut*. Usually, after the point of the knife or knife-needle has passed through the iris, all cutting ceases—it is merely *tearing*. The chief objections to the scissors, or knife and scissors methods, are the too free incisions in the globe, often lying wholly in the clear cornea, entailing undue loss of aqueous and vitreous, thus causing other dangers, and that they are, on the whole, complicated and difficult.

Irito-dialysis.—DeWecker considered a measure of last resort in those troublesome cases where, in addition to closure of the pupil, there existed adhesions between cornea and iris, and especially in

such of these as had not been benefited by other means. It consisted in making the primary combined incision with keratome or stop-knife near the center of the cornea, and facing that segment of the periphery where the iris was most nearly normal. The introduction of the blunt-pointed scissors, one blade behind the iris, and making two diverging cuts, one from each end of the first iris incision, and reaching to the outer border of the iris. The intervening segment of iris was then forcibly torn from its fastening and extracted by means of strong straight forceps. This procedure was naturally often productive of very unpleasant reaction.

Modifications.—A few of the many modes of performing the foregoing operations will be here mentioned.

Iridotomy.—Milles[1] and Nacati,[2] instead of making the corneal incision at right angles to the course of the iris fibres, recommend making it parallel therewith in order the better to direct the cut of the scissors across said fibres. Sichel[3] and Scherk[4] reverted to the Heuermann-Graefe method, but each with a knife, or rather a knife-needle, of his own invention. Sichel's instrument was something like his discission needle, only the tiny blade, instead of being curved, was straight, and resembled in form the Zehender cataract knife. The Knapp knife-needle does not differ materially from the iridotome of Sichel. Scherk's was complicated, having on the handle an attachment whereby the little lance-like blade could be given a sawing motion.

Of all forms of simple iridotomy I prefer that of Gayet.[5] This is essentially the same as that given in the chapter on "Discission of Secondary Cataract" as the method of Pagenstecher. Gayet used an ordinary Graefe knife, punctured the anterior chamber at the base of the cornea, the flat of the blade parallel with the plane of the iris; the handle was then slightly raised, the iris pierced and incised, without enlarging the corneal wound, by making the blade describe a small arc. Now, it is next to impossible to make a clean cut of the iris or of a membranous cataract (and discission is but a phase of iridotomy) by mere pressure of the edge of the knife,

[1] Royal Oph. Hosp. Rep., x, 3, 1882, p. 403.
[2] Ann. d'opht., iii, 1883, p. 403.
[3] Klin. Mbl. F. S., xv, 1877, S. 273.
[4] Klin. Mbl. F. S., xxi, 1883, S. 315.
[5] Prog. méd., No. 35, 1880.

no matter how keen it may be. The membrane will only be *pushed* along and torn. But a little sawing motion imparted to the blade, however slight, will cause it to cut. In sawing with a sharp knife, it is difficult to prevent harmful wounding or extension at the point where it engages the cornea. To avoid this, I have the edges of the Graefe knives, which are used both for discission and iridotomy, made dull and smooth, for the first two-thirds of the distance and sharp and wiry for the last, or end, third. The operation can be done in this way without any loss of aqueous, which cannot be said of the knife-needle method. This form of knife, particularly if the blade be somewhat smaller in every way than that of the regulation cataract knife, is one of the most manageable of instruments. The old and worn-down Graefe knives can be thus utilized. The corneal wound is insignificant and, being in the vascular zone, heals at once. If one is careful to make the iris incision at right angles to the direction of greatest strain of the fibres, and no inflammation of the membrane follows, a permanent round or elliptical pupil will result. Should the iris tissue be such as not to retract, or should the new pupil close from iritis, there is still time to resort to irito-ectomy.

Modifications of Irito-ectomy.—Tyrell's blunt-hook method. The primary corneal incision is made with a lance-keratome, the blade of which is made to traverse the anterior chamber to a point just beyond the limits of the proposed pupil. Here it is passed through the iris, when, by a sort of rocking motion, the cut is enlarged. The knife is withdrawn, the blunt iris hook is inserted, flatwise, at the corneal wound, pushed across to the iris wound, given a quarter turn so as to catch the hither edge of the cut, the membrane drawn a little way outside of the corneal incision, and a small piece cut off with scissors. This measure is less complex and difficult than the intraocular scissors methods, and done with less dragging upon the iris than is the operation of irito-dialysis. It is the same as the procedure described by Knapp[1] as "irido-cystectomy." The writer was led to adopt it for many cases of membranous cataract and closure of the pupil after extraction by the splendid results he had seen obtained for the procedure at the hands of the late Cornelius R. Agnew, of New York.

[1] Norris and Oliver's System, p. 792.

To obviate traction upon the iris, Abadie[1] devised an ingenious mode for irito-ectomy, by which he obtained a quadrilateral pupil. Two parallel incisions of the cornea, 5 or 6 mm. apart, made with the lance keratome, the first one smaller, the second larger and made to pierce and incise the iris to form one side of the opening.

FIG. 221.—Incisions.

FIG. 222. Result.

Introduction of tiny forceps-scissors at the larger, and extending the iris cut in this form (Fig. 221). Withdrawing the flap with iris forceps or hook at the smaller corneal incision, and cutting it off its base (Fig. 222).

OPERATIONS FOR SYNECHIA.

SYNECHIOTOMY.

These operations have for their object:

1. The cure of the defect itself, i.e., the severance of the iris from its attachment.

2. The affording of relief from the effects of the synechia.

The first constitutes true synechiotomy. In the second instance, the breaking up of the adhesions is apt to be but partial and incidental.

As the synechia is said to be posterior or anterior, according as it concerns union of the iris with the crystalline lens or with the cornea, so is the synechiotomy posterior or anterior.

Corelysis is the term that distinguishes posterior synechiotomy. Wenzel, of Paris and London, in the latter part of the 18th century, was the first to practise posterior corelysis. He broke the adhesions with a needle introduced by way of the anterior chamber, and the

[1] Ann. d'ocul., 1888, p. 261.

measure was resorted to only when the lens was cataractous. A little later, Beer did the same by means of a tiny sharp hook. The first to make the operation in cases where the lens retained its transparency was Streatfeild,[1] of London, at whose hands the procedure attained a degree of popularity. He first made an incision with the keratome, then attacked the synechia with an instrument that he called a spatula, but that was, in reality, a tiny knife bearing at the extremity of the blade a blunt hook. Weber,[2] of Darmstadt, also devised a method and a synechitome, the latter being a knife-hook with blunted point. The operation is not without danger to the lens; besides, the adhesions often refused to yield, or yielded only to recur. Moreover, iridectomy, it has been demonstrated, is a better remedy for the irititis, etc., that sometimes result from pronounced synechia posterior. A few slight, isolated attachments are usually harmless. For these reasons the operation has fallen into disuse.

Anterior Synechia.—Here the involvement of the iris is not so much an adhesion *to* the cornea as it is an incarceration, the extent of which varies greatly—from a few fibres caught up by a linear or punctate scar, to the inclusion of the greater portion of the membrane in a leucoma (*leucoma adherens*). The surgical treatment applies more to the second category just mentioned, as, aside from a few special measures and instruments relative to the synechia itself, most of the operations are but phases of those already described in connection with the iris. When the synechia involves only the pupillary border, the freeing of the iris from the cornea is called *sphincerolysis;* when a more extensive area, *iridolysis.* Here follow a few of the methods of dealing with small synechias.

Von Arlt,[3] in cases of small, anterior synechia, advised passing a lance-keratome into the anterior chamber, advancing the point to the adhesion and trying to cut it by a rocking motion of the blade from side to side. Bowman first made a small incision through the cornea, then introduced a probe-pointed lacrimal knife to divide the synechia. Meyer[4] essayed to sever the attachment with a small, blunt-pointed sickle, passed into the chamber through an incision,

[1] Oph. Hosp. Rep., 1857–1860.
[2] A. f. O., 1860 1861.
[3] Operationslehre, S. 341.
[4] Handb. der Augenb., Berlin, 1883, S. 108.

and advised cutting from the periphery toward the pupil. Of course, it was necessary that a space existed in the meridian of the synechia between cornea and iris. Lang[1] used two knife-needles, one blunted at the point. With the sharp one he punctured the cornea obliquely near the site of the adhesion, then substituted the blunt one, with which, in the withdrawing, he freed the iris.

For the more extensive adhesions between cornea and iris, a number of simple and combined measures have been employed—a few of them effective many ingenious. Naturally, the phase of irido-corneal adhesion that has specially concerned the surgeon is that where exists blindness from incarceration of the entire sphincter. I have seen Dr. Agnew obtain the object sought in such a case by inserting his angular lance as if for an ordinary optic iridectomy, then piercing the iris just short of where it entered the cicatrix, and pushing the point into the posterior chamber, thus freeing the iris sufficiently to admit of a small iridectomy, which he at once proceeded to make. Again, where the limited space between cornea and iris would not permit the handling of the lance-knife, the same surgeon would accomplish the end thus: A very narrow Graefe knife is passed into the anterior chamber close down to the limbus, the iris is partly severed from the scar with the point of the knife, counter-puncture made, the section completed, the loosened segment of iris pulled out with forceps and cut off.

For elaborations of this branch of ocular surgery the reader is referred to Czermak's "Augenärztlichen Operationen," p. 716, where are given descriptions of the very original methods of the Hungarian ophthalmic surgeon Schulek.

IRIDECTOMY.

This is a surgical measure whereby a portion of the iris is excised. The first iridectomies on record were probably those made by Daviel[2] to facilitate the removal of cataract. It was Reichenbach,[3] however, who first proposed partia' excision of the iris as a separate and independent procedure; and for making the coloboma he de-

[1] Oph. Hosp. Rep., vol. xii, 1889, p. 356.
[2] De Wecker, "Réminiscences historiques, etc.," Arch. d'opht., t. xiii, 1893.
[3] Dissertation, Tübingen, 1767.

signed a sort of punch or trephine. Janin about 1772, cut off a prolapse of the iris that had occurred in an attempt to make an iridotomy, and remarked how little was the tendency of the resulting pupil to close, as compared with that produced by the older operation of iridotomy. The elder deWenzel[1] made numerous iridectomies in conjunction with his cataract cases, either at the time of the extraction or afterward, to create an artificial pupil in atresia of the iritic membrane. These operations were mostly of the *sub-corneal* variety, i.e., the sections of the iris were made within the anterior chamber, in contradistinction to the *pre-corneal* kind, as usually practised, wherein the portion to be removed is withdrawn with a traction instrument before being severed. The great Viennese ophthalmic surgeon, George Joseph Beer, was the pioneer of the latter mode, which he first conceived in 1806. Not only this, but he greatly enlarged the sphere of the measure by applying it to cases other than those wherein the lens was opaque or was absent, as in staphyloma and opacities of the cornea, for artificial pupil. He also gave a correct method of technic and fitting instruments for the making of the operation. His broad, triangular cataract knife was used for the corneal incision, which he made as close as possible to the sclera. If there was no posterior synechia, the sphincter was caught by a small sharp hook, pulled out, and the section made with small Daviel scissors. If adhesions with the anterior capsule or cornea existed, the withdrawal was by means of tiny toothed forceps.

The operation underwent slight modifications at the hands of Beer's immediate disciples, as Walther, Langenbeck, Rosas, Chelius, Flarer, and the two Jaegers, Karl and Friederich; in England, at those of Gibson and Tyrrell, and, in France, at those of Sichel and Desmarres.[2] The last mentioned added *iridorrhexis*, or tearing of the iris from its periphery, to increase the breadth of the coloboma. But it is to the most distinguished pupil of both Beer and Desmarres, viz., the immortal Albrecht von Graefe, that the world is indebted for the inestimable value of iridectomy as a curative agent, especially in recurrent iritis and irido-cyclitis,[3] and in glaucoma.[4] Did the fame of this versatile and subtle genius in ophthalmology rest

[1] Traité de la Cataract, Neuremberg, 1788, p. 188.
[2] Traité des maladies des yeux, 1855, T. ii, p. 542.
[3] Arch. f. Ophth., ii, 1856, S. 202.
[4] Arch. f. Ophth., iii, 2, S. 456, 1857.

only upon this last-named discovery, it were enough, and more, for all time, and the beneficient results thereof were an all-sufficient monument.

As may be inferred from perusal of the foregoing historic sketch, where the chief offices of iridectomy are touched upon, the forms and uses of the operation are varied. The principal kinds and their indications may be thus tabulated:

KINDS OF IRIDECTOMY AND THEIR INDICATIONS.

1. *Preparatory iridectomy*, or that which is employed in conjunction with the extraction of cataract.

2. *Optic iridectomy*, or the making of an artificial pupil for visual purposes.

3. *Therapeutic iridectomy*, that which is undertaken for the cure or for the prevention of morbid processes in the eye.

1. **Preparatory iridectomy** is, as has been stated, the oldest form of the operation. It is, moreover, the purest form of iridectomy. It is made either immediately preceding the extraction, thus constituting the *combined* operation, or some weeks or months previously, when it is called *preliminary* iridectomy. Combined iridectomy was the original kind, having been that of Daviel and of ophthalmic surgeons in general, for more than 100 years following the introduction of the operation of extraction. It was first intended merely as an aid to the delivery of the cataract, as in cases of rigidity of the pupil, luxation of the lens, etc. Later, the procedure was resorted to in order to prevent iris entanglements (Schifferli, 1776), and, still later, with the view of warding off iritis and suppuration of the wound (Graefe, 1850). The late Prof. Mooren, of Berlin, in 1862, was the author of preliminary iridectomy, which he practised with the idea of lessening the dangers of suppuration after operations for cataract. The chief objects of preparatory iridectomy, as practised to-day, are to facilitate extraction—particularly as regards removal of cortical remains and to forestall iris complications as sequelæ of extraction. Some eye surgeons make preparatory iridectomy only as occasion demands, as in complicated cataract, the others never omit it. In this connection the operation is treated of under "Extraction of Cataract."

2. **Optic iridectomy,** or **coremorphosis,** as we have just seen, is next, in point of age, to the preparatory variety. It is indicated in *atresia iridis*, or where the normal pupil is obscured by opacities of the cornea, as partial leucoma; or of the lens, as large pyramidal and zonular cataract; in occlusion of the pupil, in subluxation of the crystalline with great reduction of visual acuity—in short, whenever it is possible by the excision of a portion of the iris to restore or to greatly improve the sight. The resulting coloboma should be small, to insure a clean image, and, when practicable, should not extend to the periphery, because of the imperfect refraction and senile changes that characterize this region. As to the position of the artificial pupil, when one has the option, it is customary to place it downward and inward. Really, provided it does not lie beneath the lid and is not too eccentric, the situation of the opening is, dioptrically considered, of little or no consequence. Indeed, as regards the lens, this is a matter to be decided solely by the site of the opacity, and, as concerns the cornea, by data obtained from careful study of the available parts of that membrane. To this end, it is of the utmost importance that not only the degree of transparency of the different areas be ascertained, by means of strong focal illumination and magnifying glasses, but that one takes into consideration their curvature, as revealed by such implements as Placido's disks, the ophthalmometer and the ophthalmoscope. Especial care should be given the opthalmoscopic examination, since transmitted light and a strong plus lens will reveal corneal areas practically opaque on account of diffraction, which could not be seen by other methods of examination. That portion of the cornea which is freest from opacities and irregular astigmatism should be chosen as the sight of the coloboma. These investigations are to be made, whenever possible, with full mydriasis, before subjecting the patient to the operation. In zonular cataract and in subluxation of the lens, one must be fairly sure that increased vision will ensue, for the best made optic iridectomy is apt to prove disappointing in these defects. A piece of card-board or other diaphragm, stenopaically perforate, used in such a way as to cause a narrow pencil of light to pass through the different parts of the dilated pupil will, occasionally, solve the problem in question. In many instances, however, the area of clear cornea is so limited that the

location of the coloboma becomes, not a matter of choice, but of necessity. If one be obliged, by the exigencies present, to make the iridectomy in an unfavorable position, other artificial means may often be evoked for heightening the visual results. If, for example, it be extremely peripheral, cylindrical lenses can, in many cases, be fitted with benefit. If diffusion is caused by the light that passes through thin opacities in the immediate vicinity of the clear spot selected, the image can be sharpened by tattooage (see page 397). The same may be done to advantage in the event of too large a coloboma, by way of "stopping down," as it were.

Now and then it happens that one is confronted with a patient whose only hope of obtaining a modicum of sight is through the making of an opening in the iris beneath a tiny area of cornea situated at the extreme periphery. If the incision encroaches upon this area, the ensuing scar will cloud the new pupil. One has, then, the choice between entering the angle of the iris through a long wound-canal by way of the adjacent sclera, or of making a combination of irido-dialysis and iridectomy, as resorted to by Panas. This surgeon would make the corneal incision on the side opposite reach across the pupil with the forceps, seize the iris beneath the spot of clear cornea, tear it from the periphery, withdraw, and excise. Both methods are difficult.

A drawback to the artificial pupil is its fixidity, no withstanding the varying intensities of illumination. It was to obviate this that Adams, in 1812, and Himly, in 1843, proposed displacing the natural pupil in the desired direction by drawing the iris into the corneal wound and there leaving it to be incarcerated—*iridencleisis*. It was to the same end that Critchett, in 1857, devised his operation of ligature of the iris—*iridesis*, or *iridodesis*. This consisted in making a small incision with a broad needle or lance-knife as near as possible to the base of the cornea, withdrawing with cannula-forceps the nearest portion of the sphincter, throwing a delicate silk ligature around the part brought out, leaving it thus for two days in order that the iris might become firmly adherent in the wound, then cutting off the extrusion or allowing it to slough. These measures proved excellent in so far as their optic effects were concerned, seeing that they gave a narrow, movable pupil, but disastrous as regarded their physical consequences—among the last having

been iridocyclitis, glaucoma, and sympathetic ophthalmia. Hence, their respective vogues were short-lived. As a safe substitute for them, in the year 1871, Pope,[1] brought forward his method of making an optic iridectomy without dividing the sphincter of the pupil. With a very narrow keratome he entered the extreme periphery of the anterior chamber by way of an almost scleral wound, allowed the aqueous to drain slowly to avoid a prolapse, seized with fine, slightly curved forceps, the iris in the center of the exact spot to be excised, and withdraw, taking care that the pupillary border came not into the incision. Then, with small curved scissors, just as much was cut off as was held by the forceps. If a round coloboma was wanted, the scissors blades were held at right angle to the direction of the corneal wound; if an oval section was preferred, the blades were held parallel with the wound. The remaining portion of the pulled-out iris was gently replaced.

Such an artificial pupil has certain advantages—among them being its small size, its slight disfigurement, and the little tendency it has to widen or to be drawn toward the root of the iris. Singular, that the procedure has so few advocates. One reason is, doubtless, the popular belief that double vision—*polyopia*—and a double pupil—*polycoria*—go together. Such, however, is not likely to be the case even when the normal pupil is unobstructed, much less so when it is obscured, as is precisely the condition for which an optic iridectomy is made. Another reason for the relative rarity of the measure is the difficulties that attend its proper execution. These, however, should not stand in the way. If, for instance, the sphincter should be inadvertently embraced in the section, the result amounts only to an ordinary iridectomy. If merely a thread-like bridge at the very border of the pupil be left behind, it amounts to the same, since it will most probably atrophy and disappear. The really substantial difficulty lies in the making of the ideal, perfectly peripheral, primary incision, which will be described under the "Technic of Iridectomy." I have several times of late, had recourse to this form of iridectomy when a highly eccentric pupil was demanded, and commend it most heartily. The common practice of introducing a blunt hook or other instrument to get rid of a pupillary bridge accidentally left in the operation

[1] Arch. f. A. u. O., ii, 1, S. 192–197.

of optic iridectomy—or any, save in preparatory iridectomy—is to be deprecated.

Sphincterectomy.—The most eligible method of optic iridectomy, where existing conditions permit the more centrally placed coloboma, as in central leucoma of the cornea, is what is called *sphincterectomy*, and is that with which Critchett replaced his unfortunate iridesis. Briefly described, the manner of performing it is as follows: Incision 3 or 4 mm. in extent with a narrow keratome, beginning in the opaque zone at the sclero-corneal junction. If deftly made, the knife may be quickly withdrawn without loss of the aqueous and without causing the iris to follow the blade into the wound. These two things are desirable for two reasons, viz., a certain depth of the anterior chamber favors the manipulation of the iris forceps, and having the iris spread out in its normal relations is conductive to the accurate dosage of the excision. With fine, moderately curved, back-toothed forceps (or median-toothed), the iris is seized near the pupil, drawn out sufficiently to expose the pupillary border, and a small triangle of the uveal lining, and, with a single snip of the curved iris scissors, or the De Wecker forceps scissors, the blades crosswise to the primary incision, a small piece, comprising a little more than the sphincter itself, is excised. The unsevered portion is gently replaced with the spatula, the eye washed with a mild antiseptic solution, and the dressings applied.

3. **Therapeutic Iridectomy.**—This variety of iridectomy is either prophylactic or curative or both. In the first capacity its chief indication is in

a. **Recurrent Iritis or Irido-cyclitis.**—In the second capacity therapeutic iridectomy finds its main office in

b. **Glaucoma.**—It is both remedy and preventive in certain instances of

c. **Foreign bodies** in, tumors, parasites, and prolapse of, the *iris*.

a. Iridectomy has proven of great value in cases of partial posterior synechia, characterized by relapses of iritis, ***provided the operation is made in an interval when the eye is absolutely quiet.*** This is especially true of cases where exists exclusion of the pupil more or less complete. For these, the excised portion of iris need be only of small dimensions, and no necessarily peripheral, except

there be a tendency to glaucoma. In complete exclusion of the pupil, unless there be *occlusion* besides, the coloboma is made to reestablish communication between the anterior and posterior chambers, and is best made upward, so as to lie beneath the upper lid; if the exclusion is incomplete, however, the position of the coloboma will be determined by that of the free section of the pupillary border. This is ascertained by noting the effect of a mydriatic upon the contour of the pupil. Associated with these conditions the iris is apt to present the symptomatic appearance known as "crater-shape," and *iris bombé*, due to a bulging forward of the free middle zone by pressure of the aqueous in the posterior chamber. It must not be supposed that this peculiar configuration of the surface of the iris always indicates that the middle zone is not adherent to the lens capsule. The apparent bellying forward may be but the swelling caused by the infiltration or the thickening to which this region of the iris is more prone, and there may be *total posterior synechia*. Under such conditions, iridectomy undertaken for either therapeutic or optic purposes, is almost sure to be a disappointment; for, aside from the difficulty of making an adequate incision, it is usually impossible to excise any but the stroma of the iris, leaving the uvea still adherent to the capsule. True, most gratifying results can, exceptionally, be obtained even where the plight is most unpromising, as note the case of Mrs. K., cited under "Specially Complicated Extractions." In these extreme cases, however, where there is total posterior synechia, especially where exists, in addition, occlusion of the pupil, obliteration of the anterior chamber, and, above all, glaucomatous tension, iridectomy and extraction combined, after the manner of deWenzel (see page 540), is oftenest the more fitting measure. If, on the other hand, the intraocular tension is markedly low, its association with the other features just enumerated constitutes a positive contraindication as regards iridectomy *and* extraction. Neither could a few isolated points of adhesion between iris and lens be construed as a cause for iridectomy unless, perchance, all other forms of treatment have failed to stop the repeated attacks of iritis.

b. **Iridectomy for Glaucoma.**—It is herein that the operation performs its highest function. This is particularly true of it in connection with acute idiopathic glaucoma, in which relation it has been

termed *antiphlogistic iridectomy.* Whatever the variety or the grade of the glaucoma—whether acute (fulminant), subacute (*intermittent*), chronic (*simple*), secondary (*symptomatic*), absolute (*degenerative*), or congenital (*hydrophthalmus*), the same surgical principles are applicable, though the technic and the instruments by which the several steps are accomplished vary with the demands of the case and are treated of in detail later.

Iridectomy, as regards its indications in glaucoma, has many limitations. In simple or chronic glaucoma it is admissible only when there is unmistakable overtension, either constant or intermittent or as a last resort. In absolute glaucoma it may, perhaps, be tried when there is also glaucoma of the other eye. In monolateral absolute glaucoma, except the progress of the affection is sufficiently well known to exclude the possibility of an intraocular tumor, such as melanosarcoma, *the eye must be enucleated at once.* In acute hemorrhagic glaucoma it is allowable. In acute idiopathic and acute secondary glaucoma following operations and injuries, the indications are positive, imperative, and immediate. The steps themselves are notably specialized, and are, in most respects, the direct antithesis of those in optic iridectomy, that is to say, the incision must be as nearly scleral as practicable; its extent must exceed that which is required merely for getting at the iris, being usually equal to about one-fifth that of the corneal limbus; the coloboma must be broad and reach to the very root of the iris; the location of the coloboma is a fixed one, i.e., in the upper segment of the iris.

c. Therapeutic iridectomy of the third class is, as stated, both prophylactic and curative; moreover, in order to fulfill the first three indications mentioned under this heading, viz., foreign bodies, tumors, and parasites in the iris, the methods to be employed partake of those appropriate to both optic iridectomy and that for glaucoma. To remove a clean foreign body which has but recently become entangled in the iris, for example, the length of the primary incision shall not be greater than is ample for proper manipulation of the forceps, nor placed back of the limbus, except when the situation demands it, nor the piece of iris excised be much larger or more peripheral than is sufficient to include the offending substance. Given, a sarcoma of the iris, however, while the same

holds good as regards the incision, the segment excised must not only be larger, all around, than the apparent size of the tumor, but must, in every instance, extend to the outer limits of the anterior chamber, no matter how diminutive nor how centrally placed the neoplasm. The same might be said concerning foreign bodies of a poisonous nature, such as copper, or those around which appear fungoid growths or pus. The primary incision will, on occasion, need to be extensive and sclerally placed.

The fourth indication in this series—*prolapse of the iris*—necessitates iridectomy when the protruding membrane cannot be replaced in its normal position, be it the result of disease, of trauma, or of an operation. The modes of dealing with this condition are elsewhere described.

GENERAL CONSIDERATIONS RELATIVE TO THE DIFFERENT KINDS OF IRIDECTOMY.

Models and management of the iridectomy instruments are treated of in special chapters as is also preparation of the eye.

Mydriatics and Myotics.—As a rule, neither a mydriatic nor a myotic is greatly wanted in fitting the eye for an iridectomy, though there are exceptions. Some surgeons advise against mydriasis in every instance. It is certainly not admissible in cases characterized by increased intraocular tension and pre-existing mydriasis. Yet a dilated pupil is desirable in certain optic iridectomies; for example, where the border of the normal pupil is hidden by opacity of the cornea, for to have the sphincter in view aids precision and lessens risk as to the lens and in the handling of the iris forceps. It also has its advantages when the pupil is narrow, particularly if rigidity of the sphincter is suspected, to promote relaxation, if for nothing else. The less traction required to withdraw the iris, the less pain and movement on the patient's part. Any untoward dilation will always disappear with evacuation of the aqueous. To have an extremely wide-open pupil while making the corneal incision would be objectionable, for the following reasons: the bunched up iris would be more apt to get in the way of the point of the keratome, would be predisposed to follow the knife into the wound, and more difficult to properly seize with the forceps. Fortunately, this does

not occur except there be glaucoma. Whenever, therefore, it is possible in this disease, to reduce a considerable or an *ad maximum* dilation by the use of a myotic, the same should be done. Thus the iris becomes better spread out and more accessible.

Anesthesia.—Narcosis is indispensable with children, irresponsible and timorous adults, and with all eyes that are hyperemic and inflamed. There is no operation in the whole domain of surgery more exacting upon the care and skill of the operator than is that of iridectomy, and all the circumstances attendant upon the measure should be as favorable as can be made. To have one's patient asleep not only renders him (or her) incapable of doing harm, but gives greater confidence to the operator. Modern methods of general anesthesia and the substances employed, such as chlorid of ethyl and nitrous oxid in conjunction with ether, have eliminated danger to such a degree as to make them applicable to most any subject. Hence, if one has any misgivings as to the patient's behavior, or as to the difficulties of the operation, he would better invoke their aid. The anesthesia of chlorid of ethyl alone is sufficient for the simpler and more quickly executed iridectomies. It is important that the narcosis be maintained until after the toilet of the wound is finished, for much depends upon the thoroughness of this feature.

Local anesthesia, too, has its advantages, for by its use the patient is not subjected to the added risks and inconveniences, as from vomiting, etc., consequent upon narcosis, and it is a satisfaction to operate upon an eye that is thoroughly under the control of its possessor. Aside, however, from their other drawbacks in this connection, just alluded to, they have others. For instance, as to cocain, if one waits to begin the operation till the iris is anesthetized, there is likely to be mydriasis, injury to the corneal epithelium, and secondary dilatation of the blood-vessels, *ergo*, hemorrhage. These hindrances might be done away with by the choice of some other local anesthetic than cocain, yet still would there remain a large proportion of cases suitable only for narcosis. Adrenalin, or its like, I have found to cause unpleasant after effects, and by their secondary action they are also conductive of bleeding.

Technic of Iridectomy.—The operation must be described in general terms, leaving specific methods and modifications to be dealt

with later. The patient lies on a table. For all upward iridectomies the operator is usually stationed at the head, though a few prefer, for these, to stand at the side nearer the eye, which, of course, necessitates an inverse handling of the instruments, i.e., *pulling* the keratome instead of *shoving* it, and *pushing* out the iris in lieu of *drawing* it out. For *inward* iridectomy the favorite place for the surgeon using the bent keratome is on the side opposite that of the eye concerned, while in downward and external iridectomies, it is on the side adjacent. The assistant takes position facing the operator. The blepharostat is used, excepting in cases where loss of vitreous is to be apprehended, in which event the assistant holds the upper lid with a Desmarres reactor and the lower with his fingers. The globe is steadied by grasping the conjunctiva and episcleral tissue close up to the cornea, just across from the site of the incision, with strong fixation forceps *having no catch.* The hold of the forceps must be deep and broad. The point of the keratome is placed at, or slightly back of, the sclero-corneal junction, with its blade almost perpendicular to the globe, cautiously shoved in till the thickness of the corneal base has been perforated or till, by the feel, it is known that it has barely entered the anterior chamber. The handle of the knife is then depressed, to bring the blade parallel with the plane of the iris, just above which membrane it is pushed along, taking care that the point engages nothing more, and that neither edge encroaches upon either clear cornea or upon the ciliary body until it is deemed wise to stop (Fig. 223). Thereupon, the handle is further depressed to avoid wounding the advancing lens, the globe is held firmly, without pressing down or lifting up on the forceps, the blade is gently withdrawn a little way, and most of the aqueous allowed slowly to escape, when the knife is wholly withdrawn. Should one wish to extend the cut in the withdrawal of the knife, the point is swung around in the direction of the proposed extension, but holding the blade pressed close up to avoid premature running out of aqueous, the handle depressed, and the incision lengthened by a steady movement which consists in shoving the whole knife to that side and at the same time withdrawing. Where an extra long incision is wanted, as in glaucoma, one makes the incision with the view to such enlargement. To this end the incision is begun, say, to the left of what will be its middle, so that in extending

toward the right, the location of the wound will be where originally planned.

The fixation forceps is here removed, provided the eye is under a local anesthetic and the patient tractable. If not, the instrument is given to the assistant. To do this is a delicate matter. The aid lays his hand, palm up, on the patient's face, slides it deftly beneath

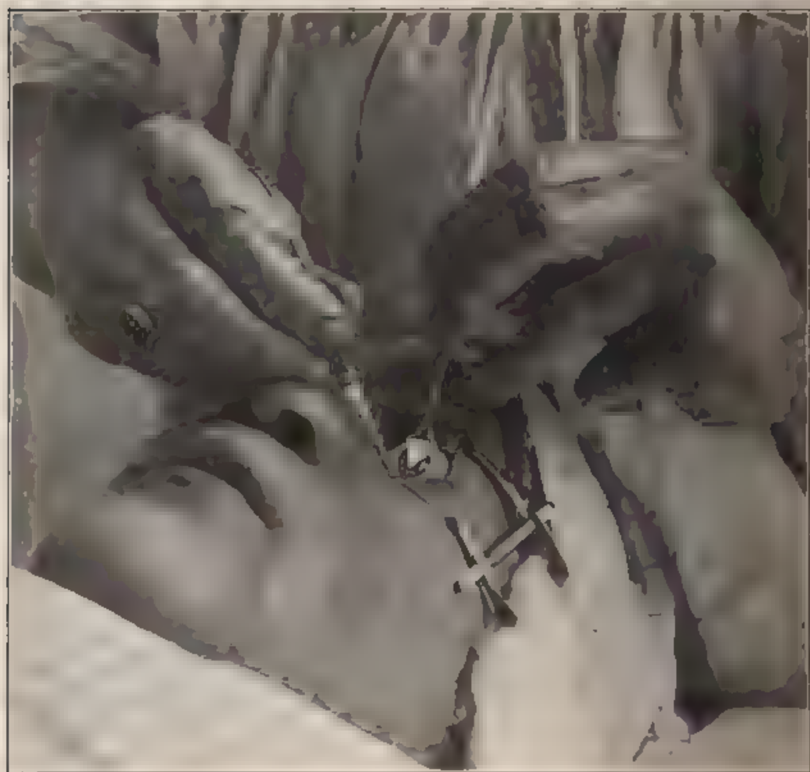


Fig. 223.

that of the operator, and grasps the blades firmly close under the surgeon's fingers. If there be any doubt as to the outcome of the maneuver, the surgeon would better release the forceps from the eye, give them to the aid, and let the latter catch his own hold. Having done so, he watches his forceps, and not the progress of the operation, save that he may know when to let go.

The operator picks up the iris forceps in one hand, the scissors in the other, the one with jaws tightly closed, the other with blades moderately open. The eye is turned so as to look somewhat downward. The tip of the forceps is placed immediately behind the incision, the scissors brought in close proximity, and both instruments held in the most stable manner. The posterior lip

FIG. 221

of the wound is depressed by the forceps, the closed blades are advanced with a slight motion from side to side beneath the anterior lip. They are made to hug the under lip until their extremities are within the anterior chamber, when they are made rather to follow the posterior surface of the cornea, not to disturb the iris, till the point is reached for seizing that membrane. The blades are now allowed to separate just enough to get the necessary hold—

usually about 2 mm. The patient, if conscious, is told to keep quiet even though a slight twinge of pain ensues, the iris is firmly, but not roughly, caught and withdrawn, all the time keeping in touch with the patient's mood and acts. As the points of the forceps emerge from the anterior chamber, the open scissors blades are slid astride them, *with* the radii of the cornea if a small excision is wanted, *athwart* them if a large one. When the pupillary border, together with a triangle of the uveal lining of the iris, appear outside the wound, the forceps are lifted sufficiently to allow the scissors blades plenty of room to close beneath, and, holding the scissors snug down upon the eye, the cut is made with one steady snip (Fig. 224). The eye is douched with warm boric or salt solution, the fixation forceps, if employed, is removed, and the lids closed to wait for a slight accumulation of aqueous. Or one may proceed at once, after the douching, to the

Toilet of the Wound and Eye.—If it had been deemed best to use the fixation forceps for the operation proper, that instrument is retained for the toilet. The same may be said as to the blepharostat or retractor. However, if the patient is well behaved and the orbicularis lax, both blepharostat and fixation forceps may be dispensed with—the operator holding back the upper lid and the patient being made to look downward the while. If no portion of the iris is seen caught in the wound, the latter is patted with the flat of the wet spatula to cause the coloboma to appear opened out full within the anterior chamber; such spontaneous return of the iris to position having occurred, it only remains to free the incision from shreds of clotted blood and bits of pigment, to see that its lips are nicely in apposition, again douche the eye, and apply the dressing. Should the coloboma not appear at all or but one pillar thereof, the tip of the spatula is inserted at the extremities (or extremity, as the case may be) just far enough to poke the entangled portion from between the lips—not deep down into the anterior chamber (Fig. 225). This having been done, the wound is patted with the wet spatula to straighten out the pillars of the coloboma. If actual extrusion of a part of the iris is manifest, it can be put in place by a gentle slicing movement with the edge of the spatula,

while, at the same time, bearing upon the lower lip of the wound (Fig. 226). A prolapse, however, that will not readily yield to such efforts at reduction, would better be pulled up with the iris forceps and cut off with the scissors. Loose ends of outlying fragments of iris must be cut off at once. Every precaution must be taken to prevent injury to the lens by a sudden turning upward of the globe during the manipulation of the spatula. The hand must be quick to draw back the instrument if need be.

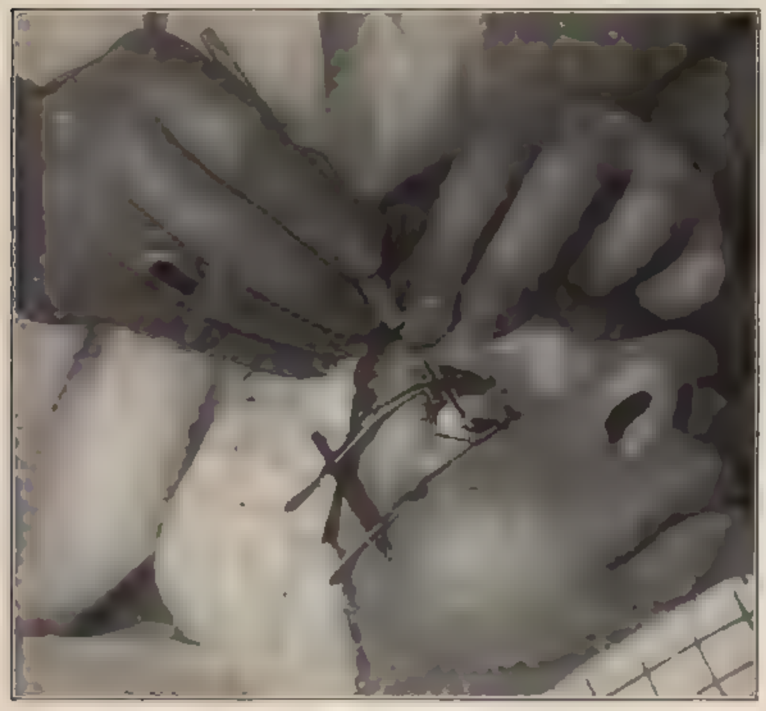


FIG. 225 Freeing the pillars of the coloboma—Pen holder fashion

After the simpler forms of iridectomy the healing is usually prompt and safe, so that the patient may be granted the liberty consistent with ordinary quietude and limited use of the unoperated eye. Binocular occlusion and greater restriction are reserved for the more complicated cases.

Modifications.—The instruments employed in iridectomy are various, and the methods subject to numerous changes, in accordance with the demands of the case and the notions of the operator. They have reference mainly to:

(*A*) The making of the keratotomy.

(*B*) The grasping and withdrawing of the iris.

(*C*) The size and shape of the coloboma.

(*A*) **Choice of a Knife for, and the Manner of Making, the Primary Incision.** In general, the bent keratome or English

FIG. 226.—Sliding movement. Left hand.

lance knife is the most suitable instrument, and the method such as has just been described. The healing qualities of its wound are exceptional, for the reasons mentioned in the chapter on Cataract Extraction. The size of the blade will vary with the extent of the incision wanted. It is best, however, that the angle between blade and handle be uniform for all sizes, as insisted upon by Knapp.

since habitual use of this particular bend insures greater precision on the part of the operator. In cases of very deeply set eyes, especially if, in addition, there are short palpebral slits, and shallow conjunctival cul de sacs, it is sometimes very difficult to make the incision in the ordinary way. Here a free canthotomy, as the first

FIG. 227.

step of the operation, will often prove a great help. In a few such instances a small Graefe knife will be found superior to the lance. To overcome the difficulties in question, Bader[1] gave to the Graefe knife a shank of bayonet shape. Others, notably Scherk, have

[1] Lancet, ii, p. 760, 1874

devised both lance and Graefe knives with shanks of similar form for like emergencies.

For the extra peripheral iridectomy in glaucoma, with very shallow anterior chamber, it will be necessary, in the use of the lance, to begin the incision 1/2 to 2 mm. back of the apparent sclero-corneal junction and push the blade straight forward with just sufficient backward inclination to cause the point to enter the extreme outer limit of the anterior chamber, keeping the wound parallel with the corneal base—aiming, as it were, for the iridic angle—having pierced which, the handle is depressed to clear the iris, but not so as to engage the posterior surface of the cornea, and thus pushed forward, only altering the plane of the blade in the event of infringing too much upon either iris or cornea, always bearing in mind that it is safer that the point should hug cornea than iris (Fig. 227). Should there be no visible space between cornea and iris, one can hardly hope to make an adequate incision with the bent keratome but must resort to either the unsatisfactory procedure of extending the cut by another instrument or to a totally different means for opening the anterior chamber. The instrument most often chosen for such cases is

The Narrow Cataract Knife.—Ever since its introduction by von Graefe, th s instrument has been used by ophthalmic surgeons for iridectomy as well as for extraction, either habitually or in selected cases. It becomes almost a necessity where there is practically obliteration of the anterior chamber. The blade should be exceedingly narrow. The incision cannot be started as far back of the apparent limbus as with the lance knife, for the reason that the plane of the iris is the same as that of the cornea, and puncture and counterpuncture would lie too close together. The point is made to enter the anterior chamber by a short wound canal, the handle then depressed, the blade insinuated a little way, not pushing it straight across, as in extraction, but rather working along nearer the periphery of the iris, even pushing back the more bulging portion of the membrane, as the blade is advanced, using the puncture as a fulcrum, until the point is reached for making the counterpuncture, or from 6 to 8 mm. from the point of insertion. Being now assured that the blade lies flat upon the iris, the point is pushed out and close down to the limbus; then the incision is completed by a steady saw-

ing motion. One may make a conjunctival flap at the finish, just as in the operation of extraction.

Adversely, it may be truthfully urged that the use of the Graefe knife leads to gaping of the wound and inability to control the escape of aqueous. Hence, seeing that the instrument is resorted to mostly in glaucomatous eyes, dislocation of the lens, jamming of that body into the incision, or even its escape, prolapse of the iris, and post-choroidal hemorrhage are all invited. The usual method is by puncture and counterpuncture, though not always. Streatfeild, for instance, would employ a rather broad Graefe or Sichel cataract knife, force it as far as practicable into the anterior chamber, then extend the wound to the requisite length by *cutting in the withdrawal.* Such a maneuver necessitates not only much skill, but an exceptionally docile patient. Somewhat less daring is a mode practised by Dehenne, which is quite practicable where the anterior chamber is shallow and but a small incision is desired. This consists in entering the outer limit of the anterior chamber with a narrow Graefe knife from a point 1.5 mm. back of the limbus, and, as soon as the point appears in front of the iris, extending the cut for four or five mm., parallel with the corneal border, by a steady motion which is a compound of pushing and sawing. To prevent torsion of the globe the grasp of the fixation forceps must be close up to the place where the incision begins.

To obtain an incision of sufficient length in an eye whose anterior chamber is lacking, has taxed the ingenuity of the ocular surgeon severely, and has given rise to a number of expediments that are, for the most part, no less perplexing than the original problem itself. To cite a few:

Brundenell Carter[1] advised making a small puncture at each of the spots marking the extremities of the incision and joining them by means of the blunt bent keratome of Desmarres, introduced first at one puncture, then at the other.

The late Prof. Gayet,[1] of Lyons, has supplied what is probably the most practicable method. The globe is firmly fixed, close to the site of the proposed incision, by the double fixation forceps of Monoyer. The cut is made with the Desmarres scarificator. The

[1] Lancet, vol. ii, p. 561, 1875.
[2] Bull. et. mém., soc. franç. d'opht., 1884, p. 41.

convex edge is placed at the sclero-corneal junction, with the blade set at about the angle which is given to that of the lance-knife in an ordinary iridectomy, and the penetration is achieved by slowly sawing, meanwhile maintaining the same inclination and keeping parallel with the limbus. As soon as a drop of aqueous appears at any part of the cut, the scarificator is put aside and the incision is finished by means of small blunt-pointed scissors. Dianoux,[1] proposed a modification of this method which consisted in substituting a Beer's cataract knife for the scarificator and a Weber probe-pointed lacrimal knife for the scissors. A better instrument than either of the last two—one less likely to wound the iris—would seem to be a small model of the Desmarres keratome.

Burnett,[2] of Washington, in cases of acute glaucoma, when the

FIG. 228.

anterior chamber is abolished, and the iris is reduced to a narrow rim or is lost sight of beneath the scleral border of the cornea, proceeds as follows: By means of a rather short stout Graefe knife, held at right angles to the surface of the globe, the incision is accomplished, from without, by successive strokes of the point. The curve of the cornea is followed for a distance commensurate with the extent of the opening desired, and as far back as is needful to insure the most peripheral position of the wound. The bottom of the cut thus carefully made finally gives way, at some point, evinced by a gush of aqueous, and, usually, a prolapse of iris. At this point is introduced a bulbous pointed, triangular knife (Fig. 228), and section of the already thinned tissue is completed. Burnett aptly observes that bleeding, which in this location would otherwise prove embarrassing, is prevented by the instillation of adrenal solution.

(*B*) **Grasping and Withdrawing the Iris.**—These acts are executed by some form either of forceps or hook. For uncomplicated iridectomies, the forceps is usually preferred. The general model conforms to the original instrument of F. Jaeger, of Vienna,

[1] *Ibid.*, p. 44.
[2] Am. Journal of Ophthalmology, April, 1902.

being of delicate make and with extremities of limbs more or less curved. As few surgeons now employ any but toothed iris forceps, the special feature of its construction has reference mainly to the arrangement of the teeth, which is a matter of choice on the part of the operator. This appears to be about evenly divided between those with the teeth placed mesially of the jaws and those situated posteriorly, called, respectively, middle-toothed and back-toothed. In both instances the teeth are even with the tip of the blades, and, in case of the back-toothed variety, they are also flush with the nether edge of the tip. It is only in those instruments peculiarly designed for grasping the adherent and the funnel-shaped iris, and in the capsule forceps, that the teeth project beyond or below the edge. These are not safe instruments for simple iridectomy, on account of the risk to the lens, though invaluable in their proper sphere. The rotary forceps of Liebreich and Mathieu, after which was patterned the forceps-scissors of De Wecker, are excellent for use with incisions of limited extent, since they admit of wide opening of the jaws without separation of the blades. The first have their teeth in the middle, the second at the back. They are, moreover, the safest forceps with which to go after a second bit of iris when the first piece excised is deemed inadequate. Many operators seem undetermined as to the breadth to which the iris should be seized, to regulate which Kuhnt[1] invented a forceps with adjustable stop, which can be set for a broader or a narrower grasp—especially useful, as in optic iridectomy, when a narrow or small coloboma is wanted. The writer's preference is for the back-toothed kind, and for correct model of the instrument the reader is referred to the chapter on Instruments and their Manipulation. By it the iris is readily laid hold of with a minimum of bearing down and tilting forward.

Iris hooks are of two kinds—sharp and blunt. The first is for engaging the tissue of the membrane itself for withdrawal, the second to catch its pupillary border. The sharp hook (of Beer) has been abandoned because of its danger to the lens and its faculty for becoming entangled within the anterior chamber. The blunt hook, the invention of Himly, though commonly attributed to Tyrell, is still used to some extent. It is particularly useful for iridectomy

[1] Centralbl. f. A., 1879, S. 138.

in the aphakial eye. In one respect it has the advantage over the forceps, in that its grasp is practically painless, while that of the forceps is decidedly the reverse. One of its greatest disadvantages lies in the fact that it cannot be made to let go promptly in an emergency. Singularly enough, this fault is due to a virtue in its construction, seeing that to be effective, the bend must be sharp and of fair depth. The blunt hook has the further advantages of easy manipulation through a very small incision and of holding the iris by a tiny area, which is favorable in dosing the extent of the excision.

(*C*) **Size and Shape of the Coloboma.**—The manner of grasping the iris with the forceps, that is, the precise location of the part seized, and its dimensions, must depend largely upon the object of the iridectomy. In the vast majority of the uncomplicated iridectomies the lesser circle, or corona, is the most eligible objective point. The somewhat greater elevation and thickness of this portion of the iris, together with the looseness of its tissue, afford a safe and ready hold. For a sphincterectomy and for iridectomy in exclusion of the pupil, when one would avoid leaving a bridge, the bite of the forceps must be as near as practicable to the pupillary border. It is possible in making sphincterectomy to grasp the iris at the outer limits of the lesser circle, withdraw till the free border appears without, then *cut in front of the tip of the forceps*, but this mode is uncertain and not to be recommended. In iridectomy for glaucoma, the point of seizure is usually about midway of the membrane, or, to be more technical, toward the inner limit of the ciliary zone, in order that the ligamentatum pectinatum may the better be put upon the stretch to insure the most peripheral coloboma. The ciliary zone is also the portion selected for the tiny forceps-bite in the optic iridectomy of Pope and in the drain iridectomy of Chandler—the last being described under "Extraction." In all instances in which the excision of the iris is made with a single snip of the scissors, the section removed embraces the part held in the jaws of the forceps, and, in addition, a strip of varying width, in proportion as much or little of the iris is drawn out at the wound, and as the blades of the scissors approach the cornea. The size of the coloboma, therefore, in the one-snip iridectomy, with a given corneal incision, will depend upon the breadth of the bite given to the forceps, the extent to which the iris is withdrawn,

and the manner of manipulating the scissors in making the cut. Accurate dosage of the excision is not possible without close attention to each of these three features. For a narrow coloboma with converging pillars the said *bite* is small, little more than the sphincter is withdrawn, and the cut is made with scissors blades at right angles to the lips of the wound and without hugging the cornea very closely. For a broader, more peripheral iridectomy, the bite is wider, the withdrawal is more pronounced, and the snip is made while holding the scissors blades parallel with the lips of the wound, even, if need be, pressing them down at the moment of closing upon the iris, in order to make a yet larger section. A convenient form of coloboma for preparatory iridectomy and the kind most suitable in the ordinary therapeutic iridectomy in acute glaucoma is the "key-hole coloboma" of Sir William Bowman. This is made by three snips of the scissors, and in this manner: As the iris is withdrawn it is pulled to one extremity of the corneal incision, the pillar of that side is formed by a snip with the points of the scissors, the latter directed toward the root of the iris; the membrane is then more strongly withdrawn, the base of the coloboma is formed by a snip parallel with the lips of the corneal wound, the iris is then pulled to the other extremity of the incision, and the second pillar of the coloboma is formed by the third and final snip which, like the first, is directed at right angles to the course of the corneal incision. This snip, however, is not made with the points of the blades only, but, to the end that the severance of the iris may be complete, the blades are placed well astride the protruding iris. In each cut the scissors are held close down to the surface of the globe, but not in such a manner as to cut the conjunctiva. For the extra broad and peripheral coloboma in glaucoma, Bowman[1] recommended tearing the base of the coloboma, instead of cutting it, cutting only the pillars, a procedure that has been attributed also to De Wecker and to Cuignet under the name of *arrachement* of the iris. This tearing away of the iris in iridectomy for glaucoma has several advantages. It admits of an absolutely peripheral coloboma with a long wound canal, whether said length is the result either of beginning of the primary incision well back of the sclero-corneal junction, or of making too slanting a wound in attempting to

[1] Trans. London Congress, 1873, p 203.

clear the iris with the keratome (Fig. 229). The anatomic arrangement of the tissues at the base of the iris is such as to cause the rent naturally to occur in the most favorable, i.e., the most peripheral situation, viz., in the cribriform portion of the ciliary zone of the iris. Indeed, it is not difficult by this method to make a coloboma whose lateral dimensions exceed the length of the primary incision, and, on occasion, one whose base is more peripheral than are the inner lips of the incision. With a good bite of the forceps, near the mid-zone of the iris, it is easy to tear the entire membrane from its attachment to the annular ligament. It is well to bear in mind the frailty of this fastening. Another condition that adds

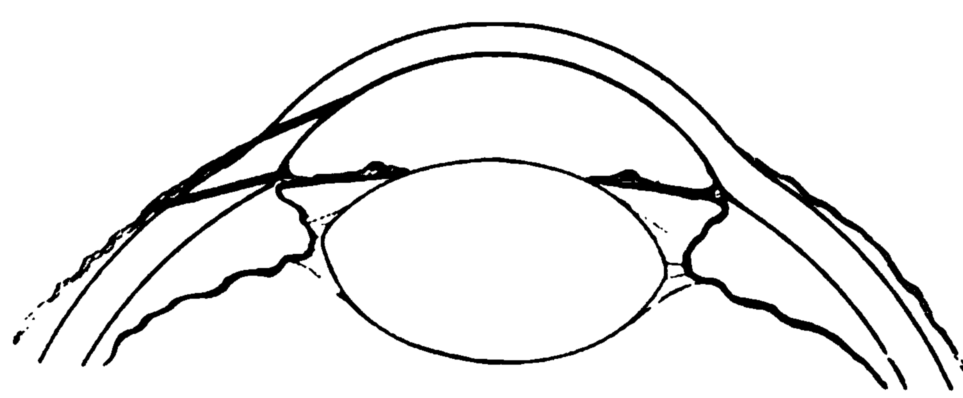


FIG. 229.—Not possible to make peripheral coloboma with either incision without tearing the base.

to the efficiency of tearing the base of the coloboma is that there is usually less bleeding than from cutting. In case of an overhanging inner lip or partial splitting of the cornea, it is best, as soon as the forceps has secured the necessary substantial hold upon the iris, to start the tear by pushing the instrument toward the center of the cornea, as it will then yield more readily than by drawing the iris at once into the wound.

Accidents During the Operation of Iridectomy.—Something untoward can occur at any step, from the beginning of the incision to the completion of the toilet. Taken in their order, those most likely to happen are:

1. **Faulty Incision.**—This has reference to the placing, the direction, and the extent. If the wound lies decidedly within the clear cornea, it is objectionable in nearly every form of iridectomy. In the optical form the scar might encroach too much upon an important transparent area. In glaucoma the drawbacks of such a wound are obvious, for, as has been seen, both incision and coloboma must here be peripheral. Then, too, the further removed

the incision from the sclera, the more liable it is to gape. On the other hand, in no instance ought the wound to be further back than is sufficient to admit of its inner lips occupying the extreme outer limit of the anterior chamber. That such should be the case, however, especially when there is considerable lack of said chamber, the outer lips of the incision will be anywhere from 1 to 3 mm. behind the apparent sclero-corneal junction. Faulty *direction* may be due to a movement on the part of the patient, as, for example, turning backward of one edge of the keratome into the ciliary body or forward into the cornea. This is particularly liable to happen while endeavoring to extend the incision in withdrawal of the knife. Hence, a timely word of caution to the patient, firm fixation of the globe, and a steady, deliberate manipulation of the knife are the best preventives. The defect in direction, however, that is most frequent is the interlamellar incision—also referred to as *split cornea* and *pocket incision*. This is usually consequent upon the mistaken judgment of the operator. In his anxiety lest he engage the iris, and possibly the lens, the knife either utterly fails to enter the anterior chamber or does so through a cut so slanting that the inner wound opening is far from the periphery and the proper grasping of the iris is difficult or impossible. If one is confronted with the first dilema, of course the aqueous does not escape, and he has but to withdraw the knife and begin over, this time with more discernment. But if the chamber is opened and the iris safe from seizure beneath the shelving nether lip of the wound, the iridectomy must be postponed for a time. An insufficient hold of the globe by the fixation forceps may lead to splitting. At the moment one attempts to make the puncture, mayhap with a knife none too keen, the considerable force required causes the grip of the forceps to yield, and the eye to rotate away from the knife, thus changing the original plane of the incision to one of a grade less steep. The making of a pocket in the cornea is usually evinced by a peculiar opacity which surrounds the advancing point of the knife. The obstacles offered by *too small* an *incision* mainly concern the opening of the iris forceps, and may be sometimes overcome by substituting the rotary forceps or the blunt hook. If neither serves, the incision must be extended by blunt-pointed scissors (Stevens' strabotomy scissors), or by some such instrument as

Desmarres' blunt-pointed keratome. Given a lance-knife with a blade at once relatively *broad* and *short*, a cornea relatively thick, and a wound canal not of the shortest, and it is easy to obtain an insignificant inner wound opening with a fairly long external one. Should one suspect such a state of affairs, a slight rocking of the knife from side to side just before its withdrawal will result in enlargement of the inner opening.

2. **Engaging the Iris with the Knife.**—This comes (*a*) of failure to alter the plane of the blade to one parallel with that of the iris the moment the point has entered the anterior chamber, or (*b*) from piercing the sclera so far back and so squarely that the knife encounters the iris before entering the anterior chamber; or (*c*) because of hugging the front surface of the iris rather than the back surface of the cornea in pushing forward the blade. The prevention in each instance is obvious. If *a* occurs and is detected immediately, the knife may be very slightly pulled back and faintly wiggled to disengage. If the involvement is more pronounced and withdrawal necessitates emptying of the anterior chamber, the operation would better be deferred. If *b* happens, the iris begins to tear from its attachment the moment the point enters it, and if the operator is not led to suspect the accident by the non-appearance of the point at the expected time and place, iridodialysis, or grave injury to the lens, or both, may ensue. At best, it means postponement of the operation. In the event of being confronted by *c*, if one is closely observant of the progress of the knife and the patient is quiet, the point may be promptly freed as soon as it catches, as suggested for *a*, its direction changed to a safer plane and the section completed. If for any reason the entanglement is such as to necessitate escape of the aqueous in trying to free it, and so peripheral as to make certain an extensive iridodialysis by forging ahead, it were best the operation be put off. It is only in case of picking up the iris at the lesser circle with the extreme tip of the blade that one might risk tilting back the handle to avoid the lens and pushing forward a short distance, even at the expense of a small rent of the iris, with the view to enlarging the incision afterward. These points have reference to the use of the lance-knife. Those relative to that of the Graefe knife are given under "Accidents During Extraction."

A rare accident that can happen to a novice using a small keen keratome, and one apt to prove most disastrous, is the shoving of the blade bodily into the anterior chamber. I have seen it occur only in student operations upon pigs' eyes.

3. **Too Sudden Evacuation of the Aqueous.**—This is an occurrence of much graver import than is commonly admitted. The usual result of the rush of the fluid is that the iris is carried with it into the wound, which, of itself, is bad enough; but, worse yet, the abrupt lowering of the intraocular pressure, even when not previously high, may give rise to choroidal hemorrhage and to rupture of the zonule and hyaloid, with presentation of vitreous or subluxation of the lens. So slightly, however, has the accident been regarded that many operators, following the example of Bowman, have, in certain simple iridectomies, regularly practised quickly jerking out the knife with the express purpose of causing a prolapse of the iris, in order to be spared the necessity of drawing out the iris with a traction instrument. The custom is much to be deprecated, for, aside from the danger just mentioned, what one gains in readily seizing the protruding membrane is more than counterbalanced by the unavoidable lack of precision in properly fashioning the coloboma under such conditions—in giving it due symmetry, and in dosing the excision. For these reasons Czermak strongly advises replacing the prolapse before proceeding, so that the seizure and withdrawal may be accomplished in the regulation way. He makes exceptions, however, as follows:

1. When the conjunctiva is so inflamed as to entail danger of infection.
2. When the tension is high.
3. When the lens is dislocated or abnormally small, as in hydrophthalmos, or when the vitreous is presenting.
4. In cases of nervous persons and children, operated under local anesthesia.

True enough, a prolapse can be brought about by other means than by carelessness in removing the knife, such as pressure upon the globe by fixation forceps, movement or squeezing upon the part of the patient, etc. Having occurred, whether or not an attempt should be made to replace it before making the excision must be

left to the discretion of the surgeon. In spite of the utmost precaution on the surgeon's part and the most praiseworthy conduct on that of the patient, a prolapse will sometimes follow the knife. This is particularly true of iridectomy in eyes whose tension is raised.

4. **Iridodialysis,** other than that produced by engaging the iris with the keratome, may happen because of an unexpected movement of the patient while the iris is in the grasp of the forceps, and as a result of a too peripheral seizure of the membrane. It is important, therefore, that one try to prevent the one by gentle words of encouragement to the patient and by anticipating his motions, and to avoid the other by a suitable hold upon the iris.

5. **Leaving behind a pupillary bridge** is not always intentional or desirable. It ensues most often through failure to draw the sphincter well out before cutting off the iris. Again, where exists posterior synechia, it may come of grasping the iris too far from the free border, or it may be inevitable on account of the firmness of the adhesion. A bridge that is free can best be dealt with by means of the blunt hook. The blepharostat is removed, a pad of cotton, wet with boric solution is laid on the closed lids for a few minutes while the anterior chamber is partially reestablished. This facilitates the manipulation of the hook. The eye is opened. The blepharostat is replaced, the globe fixed, the hook inserted, flatwise, at the incision, the bridge deftly caught, so as not to wound the lens, the hook again turned flat, brought out, and the strip of iris severed. A tightly adherent bridge would better be left unmolested.

6. **Leaving the uveal lining** of the excised portion adherent to the anterior capsule is an unavoidable accident in complete posterior synechia. Whether the object of the iridectomy is optic or therapeutic, the only alternatives, in this connection, are to leave the eye to its fate or to extract the lens. If the eye be glaucomatous, the extraction would better be made at once, first enlarging the corneal incision, then making free capsulotomy in the area occupied by the pupil *and* the pigmented coloboma. Should the tension be normal, further operating would better be postponed. *For self-protection, in no case will the surgeon fail to obtain beforehand the patient's consent—or its equivalent—to an extension of the measure originally proposed.*

7. **Wounding of the anterior capsule** is a grave casualty when the lens is transparent and in elderly individuals with opaque lenses and glaucoma, since it leads in many cases to cataract or to forced extraction to prevent loss of the eye. It is serious in any case. It is due to some fault, preventable or otherwise, in the management of the knife, the forceps, or the spatula. It is the extremity of each of these instruments that it behooves one to watch. The use of forceps with sharp teeth projecting beyond the posterior edge of the jaws is most hazardous. The spatula should be well curved and of nicely rounded end.

8. **Rupture of the Zonule.**—Aside from the too sudden evacuation of the aqueous, which has already (third) been mentioned as a cause of the accident, it may also result from too great pressure upon the forceps in grasping the iris, from sudden movement of the eye while handling either forceps or spatula, and from external pressure by patient or operator. It is highly unfortunate, whatever the kind of iridectomy. In the *preparatory* it complicates the extraction and often induces loss of vitreous; in the optic and the therapeutic it may give rise to escape of vitreous, to cataract, to secondary glaucoma, or to a worse form of glaucoma on top of one already bad enough. In other words, malignant glaucoma may follow an iridectomy for a milder form of the disease if, through subluxation of the crystalline, the periphery of that body becomes jammed in between the ciliary processes and the canal of Schlemm. Methods have been devised whereby to replace lenses thus dislocated, as, for example, that of De Wecker,[1] which consists in making, after firm union of the corneal wound, his anterior sclerotomy on the side opposite that of the coloboma, then, while the cornea is still transfixed by the knife, essaying, by means of pressure of the thumb through the intervening lid, to force the lens back into position. Such procedures are mostly unsatisfactory. It were better one trusted to immediate or subsequent extraction did the exigencies of the case seem to demand it. Should the lens become actually engaged in the corneal wound, be it cataractous or not, it should be extracted at once.

9. **Bursting of the hyaloid** usually attends any considerable rupture of the zone of Zinn and from the same causes. When it

[1] LaChirurgie oculaire, p. 155.

occurs before the excision of the iris, the latter is likely to be rendered difficult. The only indication of the break, perhaps, is the sudden deepening of the anterior chamber, more marked on the side where the incision is situated, provided the iris has not followed the knife into the wound. The backward slant of the iris, suspended in vitreous, makes the use of the forceps for its withdrawal impracticable, so, unless a spontaneous prolapse has taken place, the blunt or sharp hook must be substituted. Should the vitreous present at, or escape from, the wound before the withdrawal of the iris, it would be well to postpone the operation save in the event of most pressing need of an iridectomy. As soon as it is evident that the hyaloid has given way, all extraneous pressure upon the globe is quickly reduced to the minimum, and the eye is closed. Blepharostat, fixation forceps, etc., are discarded. If it is decided to go ahead with the excision, an assistant retracts the lids with instruments or with his fingers. If the pupillary border of the iris is visible, it is grasped with the blunt hook, if not, one may, when sure of his hand, attempt to seize the membrane with the sharp hook, catching in the stroma just where it is folded backward. It is worse than useless, however, to try to get the iris out when it is completely introverted. In cases where the luxation of the lens is discovered prior to the operation or where loss of vitreous is feared, the writer would recommend the Angelucci fixation, i.e., grasping the tendonous portion of the superior rectus, as described under "Extraction." A trained assistant is necessary. As the surgeon completes the primary section, the helper takes from him the knife and gives the traction instrument forceps or hook. Then, as the surgeon pulls out the iris, the assistant is ready with the scissors to cut it off, which, having been accomplished, the hold on the tendon is released and the lids closed. Of course, the fixation forceps has no catch. This is one of the few instances where the keratome with bayonet shank may be found serviceable.

10. **Blood in the Anterior Chamber.**—This comes from the cut or torn iris or from the incised conjunctiva. Bleeding is always more profuse when the eye is under the secondary effect of either cocain or adrenal solution. Blood in the anterior chamber is chiefly objectionable when it accumulates to considerable degree directly the incision is finished, in that it conduces to faulty technic

in the remaining steps. It can often be got out and ought to be, when possible, before proceeding, by the methods described under "Immediate Accidents in Extraction." A thin layer of blood lying between cornea and iris after the operation is concluded is of no consequence, for it will soon be absorbed, but if a greater quantity be present, it should not be ignored lest the resulting clot might serve as the starting-point of a new growth within the anterior chamber.

With regard to the consecutive accidents in connection with iridectomy, they are, in the main, such as are treated of under "Extraction," and need no repetition here. Given a fairly healthy eye and a normal iridectomy, with keratome or bent-lance incision, done under the conditions demanded by modern ideas, and few operations in eye surgery are attended with less risk in the after-treatment. The corneal wound closes in most instances by primary union, and great restriction of the patient's liberty is not needful. After iridectomy for glaucoma, on the other hand, a binocular bandage and the utmost quiet that is consistent with safety to the circulatory system are indispensable. These things are all the more to be insisted upon if the wound does not close promptly. *Tardy closure of the incision* after iridectomy for glaucoma—particularly the subacute or intermittent variety—is something to be dreaded; more so than after the ordinary extraction, for all the good that might otherwise accrue to the eye can be thereby nullified. The pillars of what had been an ideal coloboma are swallowed up, and the anterior chamber is definitively abolished. The much-lauded "filtration scar"—that is, one that is truly effective in keeping the intraocular tension within bounds—is no more apt to follow delayed than immediate closure of the incision. In short, the more quickly the anterior chamber is reestablished, the better.

A second iridectomy is occasionally required in a glaucomatous eye. It is the practice of most surgeons to make the new coloboma but a continuation of the old—an extension, as it were.

ENUCLEATION.

Enucleatio bulbi; excision of the globe; shelling out the eyeball are terms in good usage for a surgical procedure whereby

the naked bulbus is severed from its attachments and removed from the orbit. The first recorded attempt at such an operation was that of Lange,[1] but the precise method is not given. George Bartisch, of Königsbrück, Saxony, a contemporary and survivor of Lange,[2] soon after removed an eye that was in a state of procidence and, still later, described the mode of operating. He used a small razor-shaped knife; with this he cut and scraped, following the sclera, and loosening it from all connection with surrounding tissues. In a case of cancerous growth affecting the bulbous and neighboring structures, Bartisch made exenteration of the orbit, having recourse to a sort of spoon, with sharp edges, taking great care to preserve the eyelids. Fabrice de Hilden[3] instead of the razor knife, employed in a similar way a straight, double-edged, bulbous-pointed knife, which he introduced through the opening caused by a previous circumcorneal dissection of the conjunctiva. Louis substituted for the knife blunt scissors, curved on the flat, the instrument that has since been used. Notwithstanding the value of the operation of enucleation it fell into oblivion, from which it was not resurrected till near the middle of the 19th century. The classic method of ablation of the globe, on which are based all of those practised to-day, is that proposed and described by Bonnet,[4] of Lyons, as a result of his studies of Tenon's capsule. This procedure was first put into practice by Stoeber, of Strassburg, in 1842, and its technic was largely refined by White Cooper, of London, in 1850. Panas says: "The principal merit of Bonnet's operation is the conservation of Tenon's capsule, which admits of the extirpation of the globe without injury to the soft parts of the orbit." Briefly described, it is as follows:

The eye having been properly prepared and the blepharostat put in place, the conjunctiva all around the cornea is detached by means of scissors and freed from its episcleral attachments. The four rectus tendons are laid bare, lifted in succession upon a blunt strabismus hook, and divided with curved scissors, even with the sclera. This done, the globe is dislocated forward, the scissors passed behind it, and the optic nerve is severed slightly back of its

[1] Thema. Chir. Figuri. 1555, p. 313.
[2] Augendienst Dresden, 1583
[3] Observation. Chirurg., Frankfort, 1646.
[4] Annal. d'oculist, T. v, 1841, p. 27.

junction with the sclera. The globe is now held well forward, with the fingers, while the tendons of the obliques and the few remaining attachments are cut.

Slight modifications of this operation or a much altered form of it devised by Von Arlt,[1] of Vienna, constitute the methods now practised, and they are referred to as the *Bonnet* and as the *Vienna* methods. In the Von Arlt enucleation the hook is dispensed with. An assistant usually holds the lids apart with the Desmarres' retractors. We will suppose the right eye is to be removed. The operator stands at the patient's right side. With the forceps a fold of conjunctiva is picked up in the horizontal meridian, close to the nasal limbus of the cornea, and snipped. The blunt point of a pair of small curved scissors is put through the opening, the conjunctiva is incised all around, save for a small bridge at the temporal side, then dissected from the sclera and shoved well back. The tendon of the internus is seized with the forceps, and thus held throughout the rest of the operation. The blunted scissors blade is slid beneath the tendon, and the latter is cut back of the forceps. The globe is rotated downward, the scissors inserted beneath the superior tendon, which is divided flush with the sclera. The eye is rotated upward, and, in similar manner, the inferior tendon is severed. The globe is now rotated somewhat outward, while the closed scissors are passed behind it at the nasal side to locate the optic nerve, then opened to cut it. The bulbus is lifted out of its socket, the obliques are detached, and, lastly, the externus, the bridge of conjunctiva, and all remaining connections are cut away.

Agnew's Method.—The mode of enucleating that has always commended itself most strongly to the author is a phase of the Bonnet operation adopted by the late C. R. Agnew, of New York. I have never seen a published description of this procedure, but my conception of it and mode of making it, from having seen Dr. Agnew perform it a number of times, is here given. The instruments required are blepharostat (or, better, provided an efficient aid is available, Desmarres, retractors), fixation forceps, without catch, mouse-tooth forceps, Stevens' strabismus scissors, a pair of stronger blunt scissors, curved on the flat, and two medium-size

[1] Zeitsch. der Wiener Aerzte, 1859, and Handb. von Graefe und Saemish, 1874.

Graefe squint hooks, neatly flattened and rounded. The operator stands facing the top of the patient's head, as in extraction, and it does not comport with elegance to change one's position from start to finish if one's training will warrant it. On causing the lids to be held apart, if a general anesthetic be employed, as is usually the case, the globe will be found strongly rotated upward. The object

FIG. 230. First step in Agnew's enucleation.

of having the fixation forceps at hand is to rotate the eye in the opposite direction while, with the other forceps, a substantial meridional fold of conjunctiva and episcleral tissue is picked up near the upper corneal border (Fig. 230). This is snipped with the Stevens scissors between forceps and cornea, and from the opening thus made the conjunctiva is incised so as to completely encircle the cornea, the forceps all the while maintaining the first hold. By

first sliding a blade of the scissors beneath the conjunctiva as close as practicable to the cornea then working it toward the limbus with a sort of riving motion, the incision can be made very close to the base of the cornea. Still holding the bite of the forceps the conjunctiva is undermined for a few mm. all round, and the anterior prolongation of Tenon's capsule is likewise incised. Still keeping the grasp of the forceps, the scissors are exchanged for a hook which is inserted beneath the tendon of the superior rectus, and, thereafter, one hook or the other serves to fix the globe. The forceps is laid

FIG. 231.—Severing tendon of externus in enucleation.

aside, the hook shifted to the left hand, the scissors again taken, the conjunctiva and capsule pushed back to expose the caught-up tendon, and the latter severed by cutting from heel toward point of hook. Before freeing the point, however, and allowing the eye to roll upward again, and without dropping the scissors, the second hook is inserted. In this way the hooks and scissors are carried around the spiral, and continuous line of insertion of all the recti muscles, never letting go with one hook till the other is in place. It is the aim to always leave enough tissue engaged by the tip of

the hook to serve for fixation while the second hook is being inserted; but should the instrument be cut entirely free, it is easy enough to reinsert it without first fixing the globe. The operator can work from right to left, as move the hands of a clock, or in the opposite direction, or in both directions. When it comes to division of the tendon

Fig. 232. Severing the opticus.

of the externus it should be cut at least one eighth inch from the sclera so that the stump will later serve as a handle (Fig. 231). In most cases the tendons of the two obliques can now be caught and detached previous to the neurectomy, or they can be left alone until after the nerve is divided. A hook is then swept around to search for stray fibres. The strong scissors here replace the other instru-

ments, the globe is dislocated slightly forward by pressing the lids backward, and steadied by the fingers; the closed blades are carefully insinuated between capsule and sclera, *at the temporal side*, and worked back to feel for the optic nerve. Having found what seems to be the object sought, one slides the scissors above it and presses down, then below, and presses up. If it be the nerve, the globe will turn up, then down, in obedience to the pressure. It only remains to draw back slightly, open the scissors moderately, and then advance so as to include the opticus between the blades. Before cutting, it is well to again press down and up to be sure, by the movements of the eye, that the blades are really astride. A single firm snip, and the globe jumps forward followed by an extra gush of blood (Fig. 232). It is best now to terminate the operation quickly. The globe is grasped firmly in the fingers of the left hand or the stump of the externus is seized with the fixation forceps, and one proceeds to divide whatever else is still adherent. If the bleeding is not excessive, the socket is copiously irrigated with hot sublimate solution, when the flow is promptly checked. The opening in the conjunctiva is neatly drawn shut—not sutured—and any extruding shreds from the tissues beyond are cut off.

Other Modifications.—There is another French method worthy of mention. It is that of Tillaux, and is called *enucleation from behind forward.* After dissection of the conjunctiva the tendon of the externus is severed at a little distance from its insertion. The stump of tendon is seized with fixation forceps, the globe strongly rotated inward, and, with the curved blunt scissors, the opticus is divided. Still held by the forceps, the globe is drawn out through the conjunctival opening, when it is easy to detach, flush with the sclera, the five remaining tendons. Cunier made the operation in reverse manner, i.e., starting with the internus.

E. Meyer[1] carefully abstains from cutting or loosening the subconjunctival tissue in the region of the insertions of the recti. To make a passage for the hook, he incises the mucosa alongside each muscle, that is, in the interval of each one of the insertions. Moreover, in order to preserve the union between the muscle and their capsular envelops, he lifts the tendon and *shaves* it from the surface of the sclera. Lastly, to augment the lateral movements of the

[1] Bull. et mém. de la soc. franç. d'opht., 1898, p. 185.

prothesis, he closes the opening in conjunctiva and capsule by several sutures *placed vertically*.

With the idea of increasing the movement of the stump left after enucleation, De Wecker, some twenty-five years ago, after the pericorneal incision, put in a tobacco-pouch suture that included conjunctiva, capsule, and tendons of the recti. He then proceeded to excise the globe by the Bonnet method, and finished by drawing up and tying the suture. This bringing together of the tendons with their aponeuroses intact would seem to be an improvement, with respect to control of the prothesis, over the earlier and simpler operations. The arrangement of the threads has been subjected to various alterations. One of the latest and best is that of Hansell and Sweet.[1] "After dissecting the conjunctiva from the limbus, each straight muscle, together with the overlying conjunctiva and capsule of Tenon, is firmly grasped by the fixation forceps and separately sutured by single threads, before dividing the tendons from the sclera. After enucleation of the ball and the checking of the hemorrhage, the cut edges of the conjunctiva, with the muscles and capsule are brought together over the muscle bed by two or three sutures." The sense in which the sutures are directed is not specified, but as lateral movement is more to be sought in the artificial eye than is vertical, and as this movement depends, in a measure, upon the conservation of the conjunctival cul-de-sacs, to place the sutures vertically, thus closing the opening into a horizontal line, will act to deepen the lateral cul-de-sacs at the expense of those above and below.

In a series of five papers published in the *Ophthalmic Record* for November, 1908, it appears that there have come to light 18 cases of sympathetic ophthalmia following Mules' operation; i.e., the insertion of some sort of ball within the sclera. These include the original 13 collected by Cross, and 5 since reported, namely, one each by Sherman, Emerson, Gifford, Oliver, and Brobst.

The same source furnishes 4 cases of sympathetic ophthalmia following Frost's operation, i.e., implantation of a ball of some material in Tenon's capsule, one each by Cant, Lang, Sattler, and Davis.

Also nine cases of the disease after evisceration without artificial

[1] Diseases of the Eye, Phila., 1903, p. 283.

vitreous, namely, one each by Dransart, Waldispühl, Van Duyse, Forget, Hotz, Nieden, and De Wecker, and two by Schmidt-Rimpler.

Forget's[1] case can hardly be included as it was one of "optic neuritis occurring 19 months after evisceration," nor can Hotz's,[2] for it was one of "*mild* optic neuritis 3 weeks after evisceration, and recovered without removal of the stump."

Since the operation of evisceration came into vogue there have been reported 36 cases of sympathetic ophthalmia coming after enucleation.

In view of the fact that all ophthalmic surgeons and some who are not make enucleations, and that the vast majority of them make exenterations (of some kind), the few unfortunate results just quoted in connection with these two measures are of little consequence. Especially is this true of evisceration, when one considers that many of the so-called eviscerations have not resulted in the thorough cleaning out of the scleral cavity, and many others, in which although this cleaning out may have been thorough, have finished by the tying of a purse-string suture or of some other kind that caused strangulation of the circulation of the conjunctiva and that of Tenon's capsule, thus producing intense inflammatory reaction.

On the other hand, in view of the relatively small number of surgeons who have made the Mules' and Frost's operation, the showing is bad indeed for those procedures.

Intracapsular, or Intratenonian Prothesis.—In 1887 Frost and Lang,[3] simultaneously conceived and carried out the idea of implanting the glass ball of Mules in the fibrous capsule of the globe, after enucleation. Since that, glass having shown a decidedly effective propensity for extricating itself, other substances have been employed. Although the relatively few advocates of the measure out of the many who have tried it have expressed themselves as eminently satisfied with their results, a glance at a partial list of the different materials with which it has been attempted to replace the living bulbus is not calculated to strengthen their position in the matter:

[1] Arch. d'oph., p. 693.
[2] Trans. Oph. Sec. Am. Med. Assoc., 1893, p. 93.
[3] Brit. Med. Jour., vol. i, pp. 1043 and 1153.

Glass	Frost.	Rubber	Pick.
Celluloid	Lang.	Wire	Laudman.
Sponge	Belt.	Silk, Catgut	Bourgeois.
Peat	Bourgeois.	Fat from gluteal region	Barraquier.
Bone { Living, Decalcified }	Lagrange	Skin and adipose from gluteal region	Rollet.
Agar-agar	Suker.	Rabbit's eye	Bradford. Lagrange.
Vaselin	Rohmer.	Paraffin	Brockaert.
Gold	Prince.		

Paraffin is the latest aspirant for honors in this line. In an interesting article in Knapp's Archives for March, 1905, Spratt, of Minneapolis, reports 23 cases in which spheres of this kind were used, with only one known failure from extrusion. The idea is conveyed, however, that from first to last these cases had been under observation for a period of only seven months. The paraffin was of the melting-point of 60 degrees C. (140 degrees F.), made into balls about 17 mm. in diameter. The operation is as follows: After the pericorneal incision and dissection each of the rectus tendons is caught fast by a Halsted "mosquito" hemostat. One then proceeds to divide the tendons and enucleate in the usual way. The paraffin ball is placed in Tenon's capsule with common forceps. The tendons of the opposing muscles are stitched together over the paraffin by mattress sutures of chromicized catgut, Tenon's capsule and the conjunctiva are closed by purse-string sutures; the first of ordinary catgut and the second of silk. The writer of the article warns against spheres too large, and against undue tension upon the sutures. The advantages claimed for paraffin are:

1. It is non-irritating, hence least likely to be extruded.
2. The spheres can be made easily and are inexpensive.
3. No danger of being broken.
4. The paraffin adapts itself to the shape of the cavity, is soon surrounded by a fibrous capsule, and is firmly held in place by connective tissue down-growths.

Abundant experience has demonstrated that the inorganic substances, such as glass and metal, introduced in the cavity of Tenon are generally, sooner or later, eliminated, while those of organic or living tissue, thus separated from their natural environment, although grafting well in this location, unfortunately, in time, undergo so great a retraction that there remains of them but an

insignificant trace. Paraffin is treacherous in that it is prone to change its location even when not expelled. Dr. Chibret, of Clermont-Ferrand, conceived the original idea of replacing the enucleated eye by that of the pig—"*Idée Audacieuse.*" But it succeeded, in a measure. Then Prof. Rohmer, of Nancy, after having made several implantations of the eyes of animals in the peritoneal cavity, with positive results, grafted in man, in case of a blind subject, whose eye was lost from iridocyclitis and enucleated, an eye of the rabbit in Tenon's capsule. But after 2 weeks the implant was eliminated, and Rohmer, discouraged, gave up the experiment. Then Prof. Lagrange, without knowledge of Rohmer's[1] experience, undertook the same researches, published in 1901, with encouraging results. In his first article and in another, published in *La Clinique Ophtalmologique*, 1901, he declared that the result depends solely upon the choice of method that is made for the operation. Some years afterward, in 1905, Lagrange made to the French Society of Ophthalmology at Paris a new communication upon the subject. Wicherkiewicz, of Krakow, was present and saw the patients operated upon by Lagrange, and listened to the discussion which occurred. It was Rohmer who then declared that, in time, all these transplanted eyes undergo complete absorption. He contended that Lagrange would soon be disillusioned, and would return to the transplantation of balls of paraffin.

Operation of Lagrange.—He used silk threads to unite the severed tendons. After enucleating the eye he employed iced compresses to arrest the hemorrhage. He then introduced the eye of a rabbit, of appropriate size, *the cornea backward.* Over this the recti tendons were united, in opposing pairs, and, lastly, the conjunctival opening was closed by sutures. The predecessors of Lagrange—Chibret, Rohmer, Terrien and Bradfort—gave to the transplanted eye its normal orientation, i.e., cornea forward, which sometimes led to disaster, such as ulceration, perforation, and loss of vitreous.

The divergence of opinion of his eminent confrères caused Wicherkiewicz,[2] to undertake to satisfy himself personally as to

[1] Annales d'Oculistique, iii.
[2] L'Ophthalmologie Provinciale, March, 1909.

the value of this form of transplantation. In consequence, Wicherkiewicz and his assistants made 35 implantations, with a technic somewhat modified from that of Lagrange. He, like Lagrange, placed the eye in the inverse position, which is better for the nutrition of the cornea. He used catgut to unite the recti tendons. The Tenonian cavity was first irrigated with cold, sterile, physiologic salt solution. Fifteen were children. In 32 instances chloroform narcosis was employed, and in 3 local (Schleich's), with novocain and adrenalin. These last reacted much more severely than did the chloroform cases. In 24 cases there was no marked reaction. In a few instances the threads cut out of the tendons, necessitating their renewal. Once there was copious hemorrhage beneath the conjunctiva. In two pronounced exophthalmos occurred, the result of deeper hemorrhage. In eleven there was considerable edema of the conjunctiva. Wicherkiewicz's operations demonstrated that the eye of the rabbit "takes" readily in its new soil. As an illustration of the intimacy of its union with its surroundings, in one of Wicherkiewicz's cases the original eye had been removed because of a malignant tumor, the growth recurred and penetrated to the interior of the new eye. It was also demonstrated that the grafted eye progressively lost volume in all cases, and that this atrophic process was most marked in the older subjects, in whom it did not cease until the graft disappeared completely; while, as regarded the children, it remained of fair size, even at the end of two years. For these reasons Wicherkiewicz now limits the operation to children and to those adults who are in urgent need of an enucleation, but will only consent to undergo it by being promised that another eye will be put in to replace that which is sacrificed. In children, who are too young to wear an artificial eye, the grafted eye, according to Wicherkiewicz, serves to fill the socket, prevents falling in of the free borders of the lids, obviating irritation from the lashes, favors development of that side of the face, and prevents the ugly sinking backward of the upper lid and the formation of the deep orbito-palpebral furrow.

Enucleation.—General Considerations as to Technic.—If one is blest with a trained assistant, the operation of enucleation is greatly facilitated by entrusting to him the opening of the lids by means of a pair of Desmarres' tractors. He knows just how to

follow the course of the operator with the points of widest separation of the lids, now widening the palpebral fissure most externally, now internally; now lifting high the upper lid while easing up on the lower, and *vice versa*, always guarding the free borders from a snip of the scissors. In the absence of such help, the Mellinger blepharostat serves, by reason of the parallel opening of its lid-holders, as the best substitute.

Detaching the Recti.—It is in respect to this feature that the Arlt method departs farthest from that of Bonnet. For the few uncomplicated cases where the relations of the parts are normal, the Vienna mode, without squint hooks, offers to the skilled surgeon an opportunity for exceedingly brilliant work—an excision of the globe in a little more than one minute, and with the use of but two instruments. But for less experienced operators, and for the more difficult cases, such as shrunken or flabby globes and those characterized by inflammatory processes, with adhesions to the surrounding tissues, no matter how clever the surgeon, it is not to be recommended. The tendons cannot be picked up so easily and divided so precisely with the scissors alone as with both hook and scissors, and there is greater liability of wounding the fibrous capsule of the globe which, in view of possible infection of the cellular tissue of the orbit, is by all means to be avoided. The Bonnet method, as modified by Agnew, admits of nearly or quite as rapid an excision in the simpler cases, and both simplifies and hastens matters as regards the complex ones. When the tendons can be readily caught upon the hook, no other fixation of the globe is necessary, but where extensive adhesions exist, one may either leave a bit of tendon attached as a hold for ordinary fixation forceps or, what answers better, have recourse to the tenaculum forceps, the grip of whose talon-like extremities may be varied at will.

Dividing the Opticus.—Most writers have taught that, for this purpose, the scissors should be inserted at the nasal side, arguing that this affords the shortest route to the nerve. It would seem, however, that those who favor the external route have decidedly the advantage. The manipulating of instruments at the temporal side in operations upon the globe is always handier than at the nasal side. Then, the diverging outer wall of the orbit makes the opticus more accessible from that side. Moreover, as the larger

blood-vessels lie more to the nasal side there is less risk of excessive hemorrhage by choosing this way. It is not advisable to rotate the globe strongly to bring the nerve nearer to the scissors in severing it, as this is apt to result in mangling the bottom of the eye-socket, in oblique section of the nerve, and in greater wounding of blood-vessels, with unnecessary bleeding. I have never felt the need of any instrument other than the medium-sized curved blunt scissors for this step in the operation. The bifid spoon of the elder Terson (Plate VIII) and the hemostatic clamp attachment for the scissors of Warlomont (Fig. 233) sometimes employed in this connection having always struck me as a useless augmentation of an already adequate apparatus; therefore, subversive of the wholesome rule

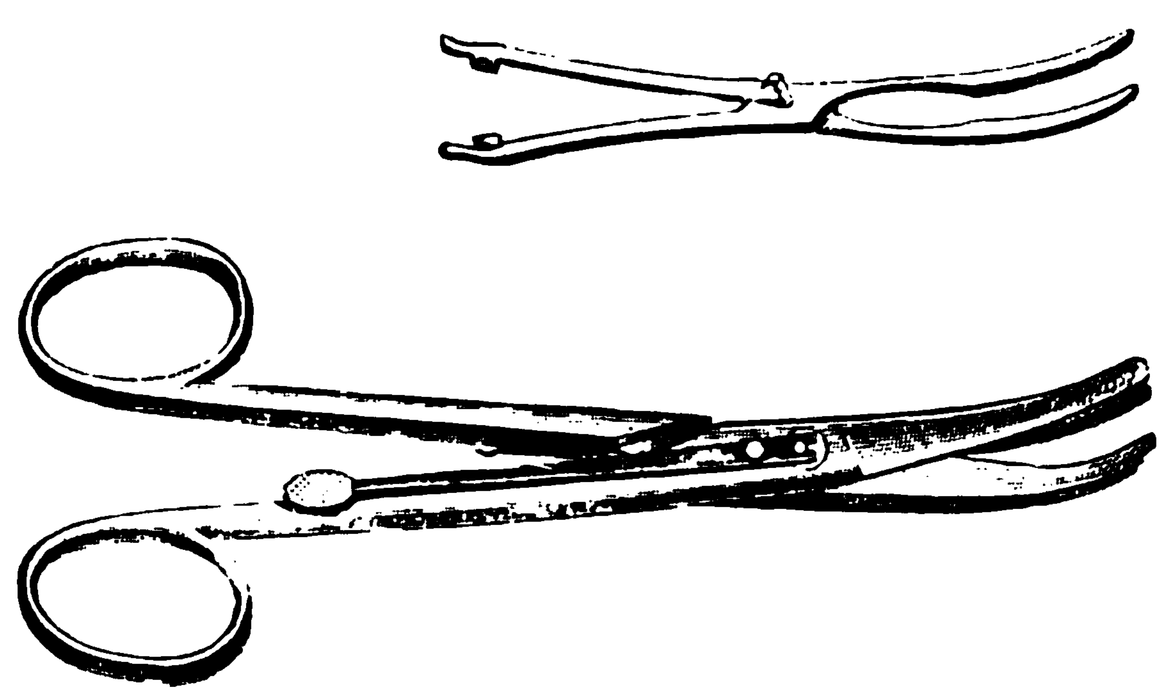


FIG. 233. Warlomont's hemostatic scissors.

that the fewer the instruments the better—always provided the results are in no way prejudiced by too scant an equipment. If there be a tumor of the posterior hemisphere or one that fills the vitreous chamber, it is best to remove as much of the opticus as is practicable. The same is true of cases wherein signs of impending sympathetic ophthalmia are present in the fellow eye. Knapp is the author of a convenient and efficient mode of making this resection. Before cutting the nerve he passes behind the globe the closed blades of a delicate pair of hemostatic forceps, curved on the flat, feels for and seizes the nerve a few mm. behind the eye, and locks the handles. He then introduces the scissors and severs between the point of fixation and the optic entrance. After the bleeding has ceased, the nerve is drawn forward by the still adhe-

rent forceps, and as much cut off as is deemed sufficient. Indeed, when the enucleation is made because of a small tumor, and inspection of the section of the opticus shows that it is normal, the forceps may be released without making the resection.

Suturing the conjunctival opening accomplishes no special good. Healing is as safe and prompt and smooth without it. Granulation buttons seem to occur about as often with as without. On the contrary, it prolongs the operation, increases the number of instruments, becomes foul with the discharges, acts like a seton in the tissues, and in the end necessitates an operation for its removal.

IMMEDIATE ACCIDENTS.

1 **Perforating the Sclera.**—This is most likely to occur in eyes of normal, subnormal, or increased tension by pulling up too strongly on a tendon while detaching it from its insertion, especially when the scissors are rather pointed or are made to hug the sclera too closely; and in eyes of reduced tension by attempting to sever the opticus flush with its entrance while making undue forward traction upon the globe. The most serious objections to this mishap are that it embarrasses the subsequent steps of the operation and that, in the event of the contents of the eye being septic, there is danger of infection of the tissues of the orbit.

2. **Hemorrhage.**—While in most instances there is no trouble from this source in excising the bulbus, bleeding is sometimes copious from the very beginning and throughout the operation. That from the conjunctiva and Tenon's capsule can usually be controlled by the instillation of adrenal solution or by flooding the eye with hot sterile or sublimated water, though to apply the adrenal solution too long beforehand only tends to favor the flow of blood. It is, however, upon section of the optic nerve and surrounding vessels that the worst hemorrhages are to be apprehended. This is particularly true of subjects in whom there has been marked degeneration of the vascular system. One should, therefore, exercise great discrimination in making this section. First, take care not to pop the eye too much before cutting, thus putting the posterior ciliary arteries too greatly upon the stretch, so that after their division, their distal cut ends will retract behind the fibrous capsule

of the globe and convert the whole orbit into an enormous hematoma. So tense can the tissues become from this cause as to result in necrosis of the lids. Secondly, guard against shoving the blades of the scissors too far astride the nerve, thus including the nasofrontal artery; and also against opening the blades too wide and making the section to comprehend large branches of the ophthalmic vein that might be otherwise avoided. Inexperienced operators are too prone to grow flustered at this stage of an enucleation and to poke and haggle aimlessly, deep in the orbit, provoking needless hemorrhage. If the outward escape of blood from the empty eye-cup is excessive or prolonged, it is best to tampon the cavity with wet (sublimate) absorbent cotton, and over all put a compressive bandage. This, be it observed, is but temporary, i.e., to be kept in place only until the bleeding ceases, when it is to be removed, the tampon taken out, the cavity washed, the conjunctival opening neatly arranged, the lids closed and the dressing applied in the regulation way. No foreign substance, such as cotton or sponge, must ever be left in the open wound long enough to become adherent. This can occur in a comparatively few hours and can prove extremely vexatious. It is rarely, indeed, that more strenuous measures are called for, such as the application of sesqui-chlorid of iron, ligation, or the Paquelin cautery, in dealing with the hemorrhage.

3. **Leaving Part of an Ocular Tumor in the Orbit.**—If, upon the removal of an eye for an intraocular tumor, it is discovered that the growth has become extraocular, and there is evidence that any portion remains behind, it must be sought at once and scrupulously excised. The same also as regards any infiltration of the optic nerve by a neoplasm.

4. **If the Globe be too large to Pass Through the Palpebral Fissure.**—The remedy lies in a free external canthotomy. As soon as the enucleation is completed, the divided conjunctiva and the skin are to be separately sutured so as to restore them to their normal condition.

5. **Operating Upon the Wrong Eye.**—That this most deplorable accident is not beyond the realm of the possible has been abundantly proven, and that by more than a single instance. Although one of the victims thereof may be terribly culpable, they are both deserving

of our sincerest commiseration. Let every ophthalmic surgeon see to it, henceforth, that this calamity does not happen through fault of his or through that of anyone else connected with the case. Never trust in the matter to those who prepare the patient for the operation. Examine the eye immediately beforehand. If the one to be removed has no conspicuously distinguishing external feature—as in intraocular tumor—shave the brow upon that side, or, better still, place a mark upon the forehead adjacent.

CONSECUTIVE ACCIDENTS.

1. **Secondary Hemorrhage.**—This is a contingency against which we have been repeatedly warned, yet one that seldom arises. The writer has never encountered it. Unlikely though it be, one must be prepared to meet it. For this reason it is best to have the case under strict surveillance for at least 24 hours after the operation. A mere sanguinary staining of the dressings signifies nothing. Should it be discovered that blood actually trickles from beneath the coverings of the eye, the bandage must be taken off and measures instituted tending to stop the flow—iced compresses to the lids, hot sublimate irrigation, and tamponment of the open socket, with reapplication of the compressive bandage; or, if need be, recourse to the more extreme ways and means mentioned under "Immediate Accidents."

2. **Infection.**—Cellulitis of the orbit, ascending meningitis, and thrombophlebitis of the ophthalmic vein and its adnexes are the truly grave sequels that enucleation can engender. But with due regard to the laws of modern surgical prophylaxis and to the integrity of the protecting fascia of the orbital tissues, their advent is scarcely to be apprehended. There are three main factors for the prevention of the accident in question that one should strive to eliminate, viz.: unclean implements, needless wounding or opening of Tenon's capsule and contamination from the tissues involved. The first is accomplished in great measure by thorough boiling of the instruments and cleansing of the hands; the second, by carefully dissecting up the anterior prolongation of the capsule, picking up and dividing the tendons of the ocular muscles close to the sclera with the least disturbance of the aponeurotic wrappings, and the

absolute conservation of the fibrous capsule that envelops the posterior half of the globe; the third, by the free use of antiseptic irrigation and the preservation of the walls of the globe (when its contents are septic). Here it may be again remarked that exenteration may be often substituted with greater safety for enucleation.

INDICATIONS FOR ENUCLEATION.

These may be arranged in three groups: 1. *absolute* and *imperative;* 2. *elective*, and 3. *optional.*

Absolute indications are those that leave no choice of other means of treatment. Among them are the cases for which enucleation affords either the only chance or hope of preserving the integrity of the fellow eye or of saving the life of the patient. To this group belong the following classes:

(*a*) Eyes, be they sightless or not, that are causing sympathetic irritation or the actual beginning of sympathetic inflammation.

(*b*) All blind eyes—and in this connection *blind* means hopelessly so--that are exciting or *have excited* sympathetic inflammation, no matter what the stage of said inflammation.

(*c*) All eyes, whether sightless or not, in which positive diagnosis of an intraocular malignant tumor has been made.

(*d*) All blind eyes within whose walls there is any reason to suspect the presence of a malignant growth.

(*e*) All eyes, sightless or not, where exists an epibulbar malignant growth that it is not practicable otherwise wholly to remove.

(*f*) All blind eyes with epibulbar malignant growths, regardless of the degree of involvement.

(*g*) Persistent pain referred to the eye after exenteration or optico-ciliary neurectomy.

(*h*) Extreme atrophy of the globe.

(*i*) Grave phlegmon of the orbit when sight is utterly destroyed and the operation may aid in curing the disease.

Remarks on Group 1. Class a.—Ophthalmic surgeons are almost a unit in affirming that *immediate* excision of the globe, together with a pretty generous section of the optic nerve, constitute the only remedy. There are, however, a number of men whose word is authoritative, who would place these cases in Group 2,

as admitting of a choice between enucleation and exenteration as the means of dealing with them. The inflammation having become thoroughly established in the sympathizing eye, while useful vision is still possessed by the exciting eye, then the question as to the removal of the latter becomes a problem the solution of which must be left to those who have the case in charge, as it opens a field of discussion too wide to have a place here. With regard to Class *c*, if the tumor is manifestly of insignificant proportions, expecially if its exact nature is not known beyond peradventure, it is true that the excision is not at once obligatory, and further developments might be awaited and observed—indeed, in that event it would not really belong to this class. Prominent in Class *d* are those eyes that are in a state of absolute glaucoma. It would be good practice to enucleate every one of these as soon as possible, lest hidden therein should be a dangerous sarcoma. This is particularly true when the other eye is free from signs of glaucoma and the subject is of middle age or older. To make iridectomy or any form of sclerotomy for the relief of the tension or pain, and with the view of "saving the eyeball," is worse than folly in these cases. Aside from the hazard of a lurking tumor, such eyes are, as a rule, better *out* than *in*.

Group 2. Elective Indications.—These have reference to eyes that may be regarded in the light of a menace, more or less imminent, to the well-being of their fellow, yet can be rendered impotent for harm by some other procedure, as, for example, the operation of exenteration, as well as by that of enucleation. They may be classified thus:

(*a*) Recent fresh, extensive injuries seriously involving the ciliary region.

(*b*) Eyes blind from chronic inflammations of the uveal tract.

(*c*) Phthisis bulbi, not extreme, with or without calcific or osseo-calcific degeneration of the choroid.

(*d*) Total extensive staphyloma of the cornea or of the globe.

(*e*) Blind eyes containing inextricable foreign bodies.

(*f*) Acute suppurative panophthalmitis.

Remarks. Class a.—It is remarkable to what an extent the tunics of the globe may be wounded, even when the ciliary body is included

in the trauma, yet recover promptly. Provided there has been no infection, and reparation has been rapid and complete, so long as the eye remains absolutely quiescent, plump, and of normal tension, it is not only safe to leave it in place, but it were wrong to enucleate or exenterate—irrespective of questions of sight or the location of the original wound. Should a lingering iridocyclitis or choroiditis result with, perhaps, disturbances of tension, and sight is gone, excision of the globe or exenteration should be done without further delay. Given these conditions, together with useful vision and a wound of the ciliary zone, nothing short of "eternal vigilance" on the part of one capable of properly observing, could be an excuse for not resorting to one of the operations named the moment it was found that other modes of treatment were of no avail. In the writer's opinion, exenteration is better suited to every class cited in Group 2 than is enucleation.

Group 3. Optional Indications.—This group is relatively small, containing only two classes, viz.:

(*a*) Quiet eyes, apparently normal in every way save that they are blind from total leucoma of the cornea.

(*b*) All instances of bilateral blindness in which the removal of an eye or the eyes would decidedly improve the personal appearance.

Remarks.—This group is so named because it embraces those cases concerning which it is purely a matter of choice on the part of the patient whether or not he parts with an ugly useless member. Class *b* is peculiar in that, of all the classes under the three groups, it is the only one that does not assume some degree of usefulness on the part of the other eye. Like Group 2, there can hardly be a doubt but that exenteration is the preferable procedure whenever practicable for this division also. It may be mentioned in passing that Class *a* of this group includes just the cases that are appropriate for tattooage of the cornea.

Concluding Observations. Age of Patient.—Neither extreme —that of youth nor that of age—are considered bars to an urgently needed enucleation.

Anesthesia.—Narcosis is, of course, the rule, and, all things else being equal, is most suitable. Excision of the globe has frequently

been accomplished under local anesthesia, but it is far from being a pleasant undertaking. Seeing that the really painful part of the operation is the section of the optic and ciliary nerves, it is quite possible to perform this step under chlorid of ethyl or even nitrous oxid, having executed all those preceding under cocain. For subjects who are unfit for ether or chloroform this method is highly to be recommended. Indeed, as regards the youngest class of subjects, it is practicable to make the entire operation under the ethyl chlorid. Highly inflamed and sensitive eyes do not admit of using local anesthesia at any stage of the procedure.

CHAPTER XI.

EXTRACTION OF CATARACT.

GENERAL CONSIDERATIONS.

Condition of Patient's General Health.—All that is requisite in this particular is that the patient be in his usual health and that this should be such as to give a reasonable expectation of life. While it is well, as a routine practice, to make careful physical examination, there are really very few pathological conditions existing in cataract subjects, *as we find them*, that are actual contraindications as regards the operation of extraction. Although it is almost the universal custom (with the writer among the rest) to ascertain the exact condition of the urine; neither diabetes nor nephritis are actual bars to the operation so long as dissolution is not imminent. The same may be said of cardiac disease, aortic insufficiency, etc. General arteriosclerosis, while it makes one fear expulsive hemorrhage from the choroid, should not cause rejection, but should lead to extreme caution and to the institution of appropriate preparatory measures as regards diet and other regimen; also the exhibition of remedies whose effects are supposed to counteract the evils of this disease.

Age of the Subject.—Extreme old age of itself should not stand in the way. The writer's eldest subject was ninety-two, and the result was all that could be desired. On the other hand, given an unusually youthful subject for senile cataract, the question merely hinges upon the *kind* of cataract and the manner of operating to be undertaken.

Condition of the Eye and its Appendages.—There should be no thought of operating for cataract upon an eye so long as there is any active inflammatory condition of either the globe or its appendages, such as conjunctivitis, acute catarrhal disease of the lacrimal canal, and, above all, dacryo-cystoblennorrhea. These, when present, *even in the opposite eye*, should first be got rid of.

It is not to be expected that there should actually be a normal lacrimal passage—even mucocele does not deter some good men. Old, burnt out stages of trachoma, provided there is not entropion, with trichiasis, etc., may be ignored. Bacteriologic investigation of the apparently healthy conjunctiva preliminary to extraction might seem to be unnecessary, yet it is really important as it occasionally reveals an incipient infection that would positively prohibit the operation for the time.

Suppuration of the lacrymal canal, when very slight, is best dealt with by ligation of the canal with a single thread, just at the union of the two canaliculi, immediately preceding the extraction; i.e., when the patient is on the table for the latter. With the more profuse and chronic forms, however, it is best not to temporize, but at once to extirpate the sac and as much as its practicable of the canaliculi. (See "Operations upon the Lacrimal Apparatus." Pterygium, progressive or encroaching upon the pupil should first be removed. The skin of the lids should be fairly free from disease.

Condition of the Globe.—First and foremost, there must be tolerable light perception, if not projection. One must judge of the individual case. Black cataracts and those with very thick or calcific anterior capsules may very greatly interfere with these functions, even though the deeper structures be normal. On the other hand, many eyes characterized by chronic or very old choroidal and retinal lesions and affections may give most gratifying results after extraction.

The Cornea.—Opacity of this membrane, so long as it alone does not preclude the possibility of useful sight, should not prohibit extraction. Arcus senilis presents no special obstacles to the healing process, though it is likely to cause "grooving" of the wound made for extraction.

The Iris and Pupil.—Only some active pathological process of the iris would be cause for non-interference. It is highly desirable to have a normal iris and a pupil that reacts well to light, yet if dealt with as the exigencies of the case demand, one need not hesitate to operate even when there is a very great departure from the normal. One of the author's most satisfying cases is that of a woman, blind in both eyes from anterior uveitis, exclusion and occlusion of pupils, opacity of the lenses, and even opacity of the lower halves of the

corneas—the result of punctate keratitis which afterward extended to the whole thickness. Ten years ago I made in this case upward iridectomies, then extractions ,and, lastly, discissions, and the patient has good vision in both eyes to-day—even reads and sews without difficulty.

Condition of the Lens Itself.—It is highly to be recommended that, as nearly as possible, the exact character of the cataract be ascertained, for on this often depends the surgical methods we are to pursue in dealing with it. If there is much clear, soft cortex an iridectomy is indicated, or if the anterior chamber be very shallow and the opacity be an even gray—not white—throughout, we may suspect a large sclerosed cataract which will necessitate a large corneal section. As to this point we are usually put in the position where we have but little to choose; as, aside from the fact that a certain number of cases on first presentation are those of incipient cataract, the great majority, particularly in hospital practice, have already reached or passed the requisite stage of ripeness. The circumstances under which the patient comes to us make it often the choice of two evils—to operate on an unripe cataract or to send him many miles to his home. Again, the very form of cataract that we prefer to let alone till mature, viz., the so-called nuclear, with transparent cortex, is precisely the kind that causes greatest blindness when in this unready state. Preliminary iridectomy is almost a necessity before the extraction of all highly immature cataracts.

In a large charitable institution like the Illinois Eye and Ear Infirmary, for example, where indigent cataract patients are sent to us, at the public expense, from remote parts of the State, we operate on many a cataract that in private practice, or belonging to anyone residing at convenient distance, would be allowed to grow more opaque. Yet, on the whole, considering the class of patients we have to deal with, I think the results we obtain in this hospital will compare favorably with any.

It is not wise, on general principles, to extract the lens from an eye possessed of vision, for example, exceeding one-fortieth of the normal, yet with double cataract and no better vision in either eye, even such a restriction seems too great, in view of the probable results under modern methods. The mere fact that a senile lens

is even fairly transparent does not of necessity indicate that it is not entirely operable, i.e., capable of being extracted intact. This is the case with the large sclerosed lenses. Indeed, it is not so much the so-called immature cataracts that expose to the graver dangers, but the complicated, anomalous, and degenerated ones. When the patient's only hope of continued sight is centered in one eye, then I should say do not operate so long as there is *useful* vision. If the fellow eye be sound, especially if its lens also is cataractous, greater liberty is allowable. Moreover, it is perfectly justifiable, nay, advisable, to *remove a cataract from an eye whose fellow is normal*, provided the stage of opacity is fit and the conditions in general are favorable. It is the duty of every individual to obtain what sight is possible in both eyes in order to have a wholesome reserve in the event of an emergency. True, the immediate result is not so gratifying, either to the patient or to the operator, be the operation ever so successful, as the former cannot appreciate the added vision, especially when, as it sometimes happens, an annoying diplopia ensues. Later this will disappear, whereas, if left alone the cataract would reach a stage not so favorable for extraction. It is also an error to assume that binocular single vision is impossible in such cases.

To operate for cataract upon both eyes at one sitting would, according to most surgeons, the writer included, be the height of folly unless the circumstances were peculiar. If some unknown or unforeseen danger threatened, it would likely be common to both eyes. Then, too, through the experience gained by operation upon one eye—as to the patient's behavior and as to any unpleasant physical happenings during and after the extraction—one would be in better position—would know his ground, so to speak—when it came to dealing with the other eye. True, there are some strong arguments advanced in favor of greater boldness in this regard. As, for example, through timidity the patient might refuse extraction on the second eye and thus be deprived of the benefits of bilateral vision. Again, a double extraction means practically one operation, and one course of after-treatment, which has great weight in our consideration for the comfort and convenience of these elderly and feeble subjects, particularly when they live some distance away. A recent paper by Howard Hansell, of Philadelphia, in favor of

double extraction of senile cataract, and the discussion thereon was published in the January (1904) number of the *Ophthalmic Record*, Chicago.

The Preparation of the Patient.—Let it be understood the following precautions hold good for most of the eye operations that are practiced, whether on lids or globe.

Whenever possible, the operation should be made in a well-regulated hospital. The conditions for success are neither propitious nor convenient even in the best appointed homes. The patient should be admitted to the institution at least twenty-four to forty-eight hours previously in order to give time for preliminaries. A bath is usually in order, though as regards a certain proportion of these elderly individuals, we should hesitate before actually putting them into the tub. Ordinarily cleanliness from head to foot, however, must be insisted upon.

It is necessary, too, that the bowels and the urinary organs be in a normal state; indeed, a good routine practice is to administer a cathartic, with calomel, the first evening at the hospital, followed by a saline draught the next morning. The diet should be as light as is consistent with health throughout the treatment. It goes without saying that at this time a careful examination should be made of the eyes and the results fully recorded. Examine for signs of arteriosclerosis and, if present, institute the regimen that is calculated to put such a subject in favorable condition for the operation. Light diet, an abundance of pure water, aperients, and, possibly, the exhibition of such medicaments as are supposed to reduce blood pressure. The surgeon in charge should be apprized of the findings so that he may be on his guard. (See chapter on Para-operative Technic.)

Incidentally, a little beforehand training of the patient in the different acts he is expected to perform during the operation would be well-timed, as it tends to confidence both on his and the surgeon's part. Placing him in a chair, instilling boric acid solution into the eye, manipulating the lids, having him rotate the eyes in different directions, opening and shutting them, etc., and all without telling him *why* these things are done. It is the practice of some surgeons to apply a test bandage to the eye that is to be operated, leaving it over night, with the view to ascertaining whether any undue secre-

tion from the conjunctiva occurs. This procedure I consider not only unnecessary, but positively injudicious, since the mere occlusion of the eye actually tends to an abnormal secretion through retention and consequent proliferation of bacteria normally present.

At the time appointed for the extraction, the patient is washed, combed, clad in a nightdress, over which is worn a heavier garment (sterilized), such as a bathrobe, and the feet are encased in warm, sterilized hospital slippers.

Preparation of the Eye.—As stated elsewhere, it is the writer's custom to instill a drop of atropin solution into the eye about one hour previous to the operation. After one hour the relaxation of the iris is pronounced enough, in the average case, to bring about the desired results. The indiscriminate or prolonged use of mydriatics in the eyes of elderly individuals is not without its risks, chief among which is hypertension of the globe, with its train of troubles. Then the general toxic effect is thought to increase the liability of postoperative delirium. Having applied the one drop to the eye, no more is instilled unless something in the after-treatment calls for it. The mydriasis, which disappears with the escape of the aqueous, reasserts itself, but in a feeble manner, after the healing of the incision. It matters not whether the simple or the combined method of extraction is contemplated, the mydriasis favors either expulsion of the lens, or the withdrawing of the iris for iridectomy.

For the first examination of the eye, we often wish to use a mydriatic to satisfy ourselves as to how far the pupil is dilatable and as to the appearance of the peripheral portions of the cataract, for which purposes cocain, perhaps, is the best, as its effect is transient, and it has not the tendency to excite overtension possessed by most other mydriatics. It has been argued that mydriasis leads to extrusion and entanglement of the iris at the incision. I take the ground that there is no such involvement excepting when the anterior chamber is empty or in the act of emptying, at which times the mydriasis cannot be a factor, as it is then practically absent.

Immediately before putting the patient on the table the eye is given its final cleansing, which consists of

1. The requisite manipulation and massage of the lids for the expression of the contents of the Meibomian ducts.

2. The washing or scrubbing of the entire face, up to the hair and down to the neck, giving special attention to the cilia and lids, with sterile green soap and hot sterilized water. If the supercilia are long and thick, they are shaved; if not, merely lathered and scrubbed. It would seem an act of supererogation to make a rule of shaving the eyebrows when the lashes, be they ever so numerous and lengthy, are left intact. But to trim off the cilia, save those of the upper lid near the outer canthus, were a grave mistake, as the stubs of hairs would be a source of considerable irritation. To wash, or rather to thoroughly dampen the cilia with benzin is a most excellent preparatory measure, as the residue left on the hairs after the evaporation of the liquid makes an effective coating in which the bacteria are imprisoned.

3. The patient is put into a half-reclining position and the eye copiously irrigated with lukewarm boric acid solution, the lids being everted during a part of the time. Throughout all of these preparations, great care should be exercised to avoid undue violence. A jab of the thumb, knuckle, or scrub-brush could, in the eye of these senile subjects, lead to very unpleasant results; and in the use of the cotton sponges, or other implements, one must never touch the cornea, as the consequent removal of a patch of epithelium leaves a spot especially vulnerable to bacteria.

4. A thin sheet of absorbent cotton, wet with boric acid solution, is spread upon the closed lids on which is laid a pad of dry cotton. Dry cotton is never put next the eye in a dressing nor used to wipe the lids, because of the loose fibres entering the conjunctival sac. Over all, tied obliquely around the head, is applied a two and one-half inch wide strip of sterilized muslin, or netting, and in this dress the eye awaits the moment when the operation is to begin.

When the patient is brought to the operating-table (and it is better that he be led, rather than carried or wheeled) a strong box or step is placed for him by which to mount. He is told to first sit upon the table at its middle, then to lie down, when the top of the head is placed even with the head of the table-top, lying on a thin, firm pillow.

While instructing the patient during this performance of placing him upon the table, as indeed on all occasions, it should be done in the gentlest, quietest, and most adroit manner, so as not to fluster him. We have too often seen these unfortunates victimized by brutal or thoughtless attendants, yea, by the surgeon himself, and as often observed the demoralizing effect. Storming, gesticulating, yanking, thumping, and even swearing at the patient seem to have their uses among our confrères of certain nationalities, judging from the frequency of their use; but I much doubt their wisdom in any country, most of all in our own, especially with our own people. They serve merely, in most instances, to rob the patient of whatever coolness he is possessed withal, and to lead to disagreeable complications, if not to disastrous consequences.

The entire body, up to the head, is covered with a sterile sheet. Sterile towels are placed around the neck, over pillows and (a light one) over the mouth and nose. A linen cap, with drawstring, or a rubber cap, is put upon the head, covering *all* the hair, and the string securely tied.

The Anesthesia.—I shall ever guard the pleasant remembrance of the wonder and gratitude excited in the medical world by Koller's report upon the local action of cocain in the autumn of 1883. I was then a student of ophthalmology in New York, and it was, of course, particularly the impression made upon the minds of the votaries of this branch of medicine to whom local anesthesia has proven the greatest boon that I refer. Notwithstanding the many other drugs similar in their action that have been brought forward, several of which I have tried, cocain is to-day, in my opinion, the most efficient and desirable.

Cocainization.—Three or, at most, four drops of properly and freshly prepared 4% solution of cocain hydrobromate, instilled with two-minute intervals, should be sufficient for the thorough anesthesia of the eye. It will be borne in mind that too much cocain or the too prolonged use of it tends to hypotonicity of the globe, to corneal collapse, to hemorrhage, and to exfoliation of the corneal epithelium. Between drops, and throughout the entire operation, when nothing is being done to the eye, it should be kept closed, and the lids covered with a pad of cotton wet with warm boric-acid solution.

SIMPLE PERIPHERAL CORNEAL FLAP EXTRACTION.

DESCRIPTION OF THE OPERATION OF EXTRACTION AS PRACTICED BY THE AUTHOR.

The surgeon, the patient, and the requisite apparatus having been duly prepared (see chapter on "Preparation of Patient"), the operator takes his place at the head of the table, his assistant, who has charge of the instruments and other needed articles, being at his left, and the assistant operator at his right.

If the operator is ambidextrous, he stands at the head of the table, of course, for either the right or the left eye. Should he be at all in doubt, however, as to his ability to make a satisfactory section with his left hand, he should have no hesitancy in standing with his left side to the table, for the left eye, so as to make the section with his right hand. There is nothing derogatory in thus acknowledging his slight limitation.

A few words of reassurance and instruction are spoken to the patient, such, for instance, as, "I shall not hurt you, be quiet and do not squeeze the lids," and the blepharostat is introduced. We will suppose it is the right eye which is in question, and the table has been set diagonally to the window as stated. The Beard modification of Mellinger's speculum is employed. To put this instrument in place the handles are grasped by the thumb and two fingers of the right hand and pressed as near together as they will go, while, with the thumb and middle finger of the left hand, the lids are pushed widely apart, the patient meanwhile looking *straight ahead*, and the lid-holders are gently and deftly slid into place—first the upper, then the lower—and allowed to separate by pressure of the spring alone. If the lids do not open sufficiently, ask the patient to relax the lids and, at the same time, slowly press upon the ends of the slides, thus forcing the lids apart. Cut off the lashes of the upper lid exterior to the lid-holder if in the way. This is best done with small straight scissors, meanwhile holding a thin pad of wet cotton so as to protect the eye from the falling hairs. From an eye-dropper or other suitable implement a quantity of warm boric solution is poured on to the cornea and neighboring conjunctiva (the operator will find it of advantage to warn the patient

when about to pour or drop liquid into or upon the eye, as to do so unexpectedly is apt to cause a start or a wince), after which that portion of the liquid caught behind the lower lid is imbibed by a cotton sponge.

The assistant operator places his left hand on the patient's brow and supports it with his shumb pressed firmly on the upper rim of the orbit, dropping his wrist and forearm well down so as to get them out of the way of the operator. This grip on the brow discourages a spasm of the orbicularis, aside from forcibly preventing it.

Fixation of the Globe.—The surgeon takes the knife in his right hand (for the right eye), the forceps in his left. The best point at which to take hold with the fixation forceps in upward extraction is a matter of no mean importance. The point in question is at or near the center of the inferonasal fourth of the corneal limbus; in other words, just beneath the inner extremity of the horizontal diameter of the cornea. To grasp the tissues here affords a much more satisfactory means of controlling the eyeball than does the more generally chosen one of seizing them in the vertical meridian below the cornea. It is especially effective in preventing torsion of the globe during the keratotomy. The jaws of the forceps are placed against the eye *closed*, then allowed to open. Thus the loose structures are smoothed out or put lightly on the stretch, the object being to obviate picking up too much of the conjunctiva, thereby causing it to overlap the cornea along the site of the proposed incision. The instrument is then pressed more firmly, and a good big bite is taken, and as deep a one as can be obtained. The fold composing this bite should stand perpendicular to the tangent of the limbus. If the conjunctiva proves too friable to insure a sufficient hold, try lower down or even beneath the cornea. The forceps referred to here are without a catch or lock and have broad jaws. If, while the knife is engaged in the section, the fixation becomes insecure because of a purely conjunctival bite, twisting of the forceps on its long axis will tighten the hold. The second finger rests upon the patient's nose, the third and fourth upon the opposite cheek, and the hold is steadily maintained, meanwhile scrupulously avoiding either to press or to pull upon the eyeball. Now, *a look is given at the knife to see that its edge is directed upward,* and the incision is begun.

Puncture.—The point is placed exactly at the apparent sclero-corneal junction, just on a level with the union of the middle and upper thirds of the vertical diameter of the corneal base. Puncture and counterpuncture may be a trifle *lower*, of course, but it is hardly wise to begin *higher*. Rest the little finger on the patient's cheek, and have him look down—not a bad idea to direct him also to hold the mouth and the other eye wide open. The handle of the knife is elevated to about 45° to a tangent of the corneal curve, and

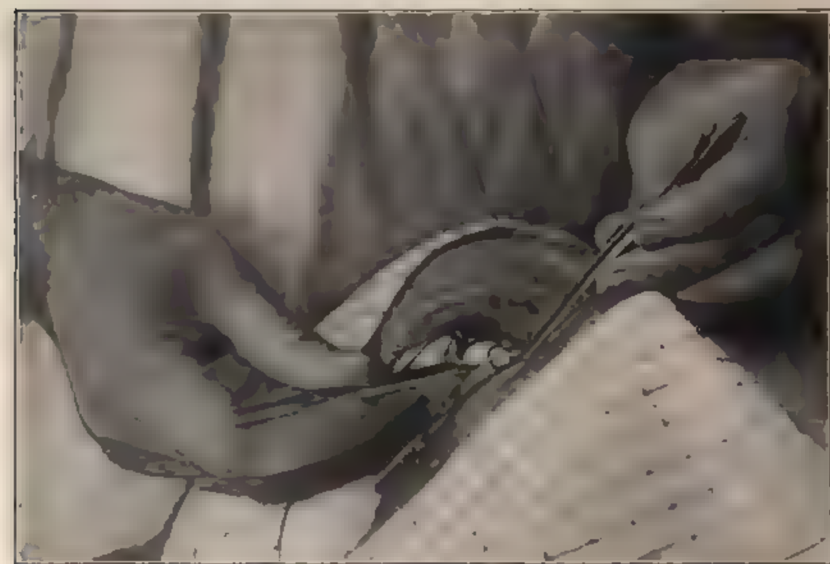


FIG. 234. Puncture and counter-puncture.

pushed until, just as it is entering the anterior chamber, the handle is depressed, in one sense, till the blade is brought parallel with the plane of the corneal base, and elevated, in another sense, so as to point toward the center of the pupil, advancing all the while; then again depressed (toward the patient's feet) and made to emerge from the anterior chamber precisely opposite to the point of entrance (*counterpuncture*) (Fig. 234). Now, onward, vigorously, without hesitation, first *pushing up* the blade to make the cut on the inner side of the cornea, then *pulling* it up to cut the outer side, holding it flat on the iris, and following the apparent sclerocorneal junction

rather rocking than *sawing*—till, when the edge has just reached the upper angle of the iris, it is given about one-eighth of a turn backward, and made to emerge beneath the conjunctiva, so as to make a small conjunctival flap (Fig. 235). The length of this flap should be about three or four millimeters, and the width four or five millimeters. When sufficient of the conjunctiva has been lifted up, the edge of the knife is suddenly turned directly forward and the flap cut off. The fixation forceps is now removed and the operator, himself, may support the brow. Before going further the con-

FIG. 235.—Finishing the cornea. section and fashioning the conjunctival flap

junctival flap is turned down over the cornea, else it may give trouble later by getting into the incision. This is best done with the back of the ready-to-be-discarded knife and not with any instrument that has yet to enter the globe.

In completing the corneal section, it is best to slow up somewhat so as to cut out without a sudden jerk, as this might have the effect of producing a prolapse of the iris or of causing an involuntary movement on the part of the patient, such as a spasm of the orbicularis. Indeed, the only period in the making of the section that should be as brief as possible is that between the instant of counterpuncture and the moment when the edge of the knife has just passed

beyond the upper border of the pupil. A certain rapidity of execution here insures against catching the iris upon the knife. Take care not to prick the lid or the nose with the point of the knife, as it causes the patient to start and squeeze and also soils the knife. In addition to supporting the brow, particularly with nervous or agitated patients, a useful precaution is to have a trained assistant

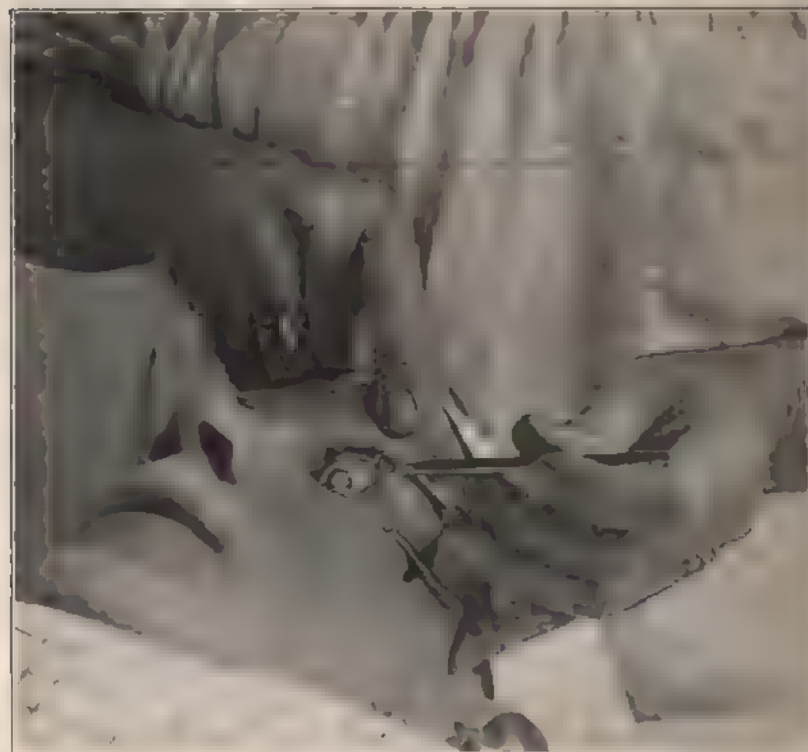


FIG. 236. The cystotomy. The shank of the cystotome should be straight in order to turn without wabbling.

elevate the lid holders of the blepharostat so that they will not lie on the globe.

Every now and then a word of encouragement spoken to the patient, as "all is going well," "soon over now," and never failing to express commendation of good behavior, are things well to remember.

The Cystotomy or Capsulotomy. The cystotome is held pre-

cisely as in the accompanying illustration and in a perfectly horizontal position (Fig. 236). The heel of the instrument is slid gently beneath the conjunctival flap, thence down over the iris until it is just within the upper portion of the pupil; then pushed behind the iris at the nasal side, holding the blade flat and the point or edge

FIG. 237 The application of the spoons for expression of the lens.

upward all the while. Now the handle is given a one-quarter turn toward the operator, so as to bring the point squarely in contact with the capsule and, pressing lightly and slightly elevating the handle, an incision is made, in a light curve, almost parallel with the equator of the lens. This is carried as far to the outer side as was its beginning to the nasal, when again the quarter turn is

again made toward the operator, to bring the heel upward, and the instrument is slid out at the incision, heel foremost.

Delivery of the Cataract. The back of the Graefe spoon is placed against the globe, well down in the lower fornix, and the back of the flat spoon is laid on just behind the incision above; the patient is told to look constantly downward (Fig. 237). (Some operators have a light held low down for the subject to fix his eyes upon.) The lower spoon is pressed firmly and steadily, but not too forcibly, toward the center of the globe, while with the upper one the

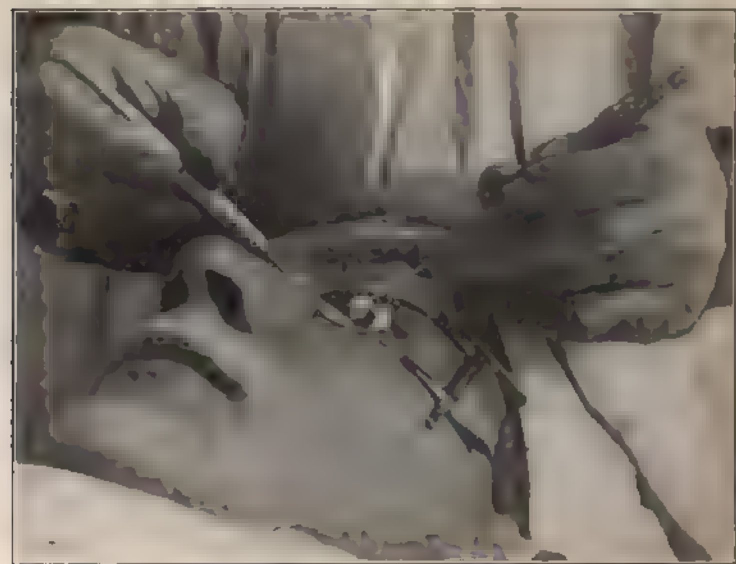


Fig. 238. Moment in the delivery of a cataract when the cortex should be driven up.

posterior lip of the incision is depressed, keeping both still, i.e., not rubbing them back and forth nor up and down. It is a curious fact that the eye, when profoundly cocainized often loses its sense of orientation, so that the patient cannot with certainty give it the desired direction, hence the advantage of giving him a bright object on which to gaze.

The first effect of the impact of the spoons is to cause a slight parting of the lips of the incision. Mayhap the advancing lens is covered by the iris; if so, only blackness is seen in the opening.

This must be differentiated from another sort of blackness, viz., presentation of vitreous. Pretty soon there is a separation of the black from the anterior lip of the cut, and the edge of the cataract rises between. Its appearance is quite characteristic—looking gray, of irregular surface, and may be likened to a bit of dirty ice that has been slightly thawed. It should be borne in mind that a too rapid delivery of the lens is harmful.

The cataract having presented its edge in the incision, it gradually advances, spoons being held still and the same pressure kept up until, when the widest part of the lens is just passing out of the incision, the lower one is slid upward, the patient is warned not to squeeze when a bright light enters the eye, and the lens is so delivered as to cause as much as possible of any following cortex to come out with it (Fig. 238). This is accomplished by pausing just when the greatest diameter of the lens is engaged in the incision, and driving the cortex upward, collecting it in a mass about the lens, by gently stroking the cornea with the back of the spoon; then, with one final sweep, delivering nucleus and cortex together. Wilder, of Chicago, is the author of this valuable maneuver. When it is clear out, if there is thought to be any cortical remains left behind, they may be removed as follows:

Removal of Cortex.—As this is a description of the simple extraction, it is assumed that the cataract is of a kind favorable to the operation. Hence, those portions that are stripped off in the delivery are supposed to be mainly opaque—*visible.* Moreover, the appearance of the cataract that has been removed, gives an idea as to about how much of it may have been left behind. The more complete it is in form, the less the residue. The consideration of transparent lens remains is found elsewhere (see page 535).

The blepharostat may be taken away, the lids closed, and a pad of cotton, wet with boric acid solution, laid on them for a few minutes, while a certain amount of aqueous accumulates. This is supposed to favor the "milking" out of the lens remains. However, this necessitates either replacing the speculum, which is not always a safe procedure at this stage of the operation, or using the retractor or fingers to hold back the upper lid, exposing the instruments and incision to the cilia and to the contents of the Meibomian canals. Besides, the pupil would, in many instances, become much narrowed

during the wait, shutting the cortex securely in the posterior chamber, thus making it impossible of extraction. For these reasons the writer prefers to go ahead at once without removing the blepharostat.

If the patient is of the irresponsible kind, the assistant, if he be clever, might steady the eye with the fixation forceps during this process, but I have for a long time proceeded alone in all cases, trusting to the special design of the blepharostat and to the holding up of the brow to prevent loss of vitreous.

The site of the incision should be kept bathed with boric acid solution and the spatula and spoon wet with the same. If the iris has been displaced during the delivery of the cataract, it is left so until after the cortex is disposed of. A prolapsed iris rather favors the expulsion of lens remains, whereas, should there be a pause just prior to this step, the iris is apt to go back spontaneously and complicate matters by shutting off the cortex from the anterior chamber. The brow being still supported either by the assistant or by the third finger of the surgeon's left hand, the patient looking down, the assistant still holding up the speculum, the spatula (in the left hand) is entered, vertically, for the double purpose of holding back the iris and affording a chute, or inverted shoehorn office; meanwhile, from without, the Graefe spoon, held in the right hand, is used to follow up the particles by a very gentle patting or rubbing process upon the cornea, until all of them seem to have been removed. The globe must be closely watched during this procedure so that should it, as it often does, turn suddenly upward, the spatula may be as quickly withdrawn, else there is danger of its puncturing the posterior capsule or rupturing the hyaloid and letting out the vitreous. While it is important that we should do our utmost to that end, it is not always possible, even under favorable conditions, to remove all the opacity from the pupil, as a portion of the posterior cortex may adhere closely to its capsule, or there may be a visible thickening of either capsule, and it is not wise to fuss too long with that which shows no disposition to come out. This will often successfully resist efforts at removal even by *lavage*.

A few surgeons still employ intraocular irrigation, or *lavage* of the anterior chamber with a neutral liquid or a mild antiseptic solution, but it is not favored by the great majority except in selected cases. When I was a student in Paris, I became favorably im-

pressed with De Wecker's method of *lavage*, and bought one of the syringes he devised for the purpose, but have never employed it but once. De Wecker afterward abandoned the procedure At the same time, Panas, after all his extractions at the hospital *Hôtel Dieu*, was performing a species of *lavage*, not for the washing out of cortical remains, but as a means of preventing sepsis There have been a number of irrigators and syringes devised for washing out the

FIG 239 Intraocular lavage. Lippincott's instrument

anterior chamber, among the best of which are Lippincott's (Fig. 239 and McKeown's. Lippincott has been the foremost and most constant advocate in this country of intraocular *lavage*.

Some operators counsel entering the cannula into the anterior chamber, some into the capsule itself, while others are content with merely depressing the posterior lip with it, and not pushing it beyond the inner wound opening. The reader is referred to a paper

by Lippincott, of Pittsburgh, in the *American Journal of Ophthalmology*, for July, 1904, for the description of his latest irrigator, together with a discussion of the technic and indications for *lavage*. It may be added that the advocates of the measure advise against prolonged and forcible irrigation and against the use of any but the blandest liquids and the mildest antiseptic solutions, such as sterile water, normal salt solution, etc. Eserin is never employed after the extraction because its effect favors posterior synechias and iritis.

DON'TS.

Rather than overburden the description of the operation with details, the latter are here subjointed as *don'ts*.

Don't get shaky. Pick up the knife, make a few finger movements with it and, if the hand is turning craven, just call a slight halt, resort to a little inward discipline, and one can usually regain his composure. A colleague once told me that when he found himself becoming demoralized on the eve of an operation, he walked to the window and, while apparently taking in the view, proceeded to give himself, mentally, a sound castigation, with the invariable effect of restoring his calm.

Don't drop cold or hot liquid into the eye during or after the operation—have it lukewarm. Don't let it fall from a height onto the eye and lids, as all tends to produce wincing. Don't squirt nor fire solutions *at* the eye, but pour them gently over it, and always warn the patient of your intention. Don't permit sponges to touch the cornea and disturb the epithelium.

Don't begin the instillation of the cocain solution until it is known that the operation can follow in not more than ten minutes. Don't let the speculum fly out of the fingers like a Jack-in-the-box while in the act of putting it in position. Get a good, firm grip on it.

Don't pry the lids too far apart, for it induces spasm of the orbicularis and increases intraocular tension. Don't allow the speculum to rest heavily upon the globe. Don't fail to lift it away from the eye, and with a firm grasp, in removal.

Don't use fixation forceps that have a catch, and don't forget the hand that holds the forceps while fixing the eye. Don't rotate the eye with the forceps as if it rested with its posterior surface

on a transverse vertical plane, but as it is, like a ball that turns on a universal central pivot.

Don't seize merely a fold of conjunctiva by which to steady the eye, but in addition, as much as possible of the subjacent tissues and as near as practicable to the cornea. Don't employ fixation after the bulbus is opened unless the need is urgent.

Don't neglect to test point and edge of both knife and cystotome before they are disinfected, to see that they are sharp. Don't use a knife with long needle-like point—the tip might break. Don't hold the knife so tightly as to cramp the fingers, nor yet so loosely as to cause wavering. Don't attempt either corneal or capsule incision free hand. No matter how steady the latter, always rest the little finger on the patient's face not only for support, but in order to move *with him* should he stir.

Don't haggle, fuss, nor hesitate in making the section, yet, while forging steadily ahead, do so with a certain deliberateness. Faulty sections, premature escape of aqueous, etc., come not so often of slowness as of vacillation.

Don't lose sight of the patient's demeanor. If this be favorable throughout the corneal section, it is apt to be so for the entire operation. If he begins to squeeze, pause, even though in the midst of the incision, and remonstrate with him in a kindly tone, and have the assistant guard closely the brow and speculum.

Don't take the eyes off the site of the operation *for an instant.* Have the assistants so trained that it will not be necessary for the operator to seek instruments and implements, nor to lay them down. Be in the closest touch with the subject, allowing not a single break in that subtle, intuitive current whereby we anticipate a move on his part.

Don't scrawl all over the capsule and zonule with the cystotome. Take pains to place the point properly on the cataract just where the opening should begin—not hastily; elevate the handle until the point is sure to have engaged the capsule, then draw it very lightly along, making a definite cut, and note that the lens responds to the liberation by springing forward. If not, it is better to go over it a second time, there and then, trying to improve upon the first effort, than to be obliged to again enter the instrument.

Don't triturate the cornea too much with the spoon in delivering

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the cataract, nor rub it about in an aimless sort of way to get out the cortex. Be sure that the *back* and not the *edge* of the instrument is applied. Don't stop to pick up the extracted lens unless it is caught deftly upon the upper spoon—merely brush it aside until the operation is terminated.

Don't have the instruments dripping wet, as the liquid, streaming downward, carries bacteria from the fingers to the eye. Don't hold instruments in the mouth to disembarrass the hands. Give them to an assistant or lay them down.

Don't talk any more than necessary, and never with explosive aspiration, to emit showers of germs, even though mouth and nose be covered by a mask.

It is the better part of wisdom to close and bandage the eye as soon as practicable after the extraction of the cataract, and to discourage all unnecessary movement or turning of it. With this in view, little exhibitions like having the patient count the operator's fingers or to tell the time on a watch, through a convex lens, it is deemed prudent to omit. Such things were formerly supposed to be a test as to whether any portions of the cataract were left behind, but as such the performance is a delusion.

The Toilet of the Eye.—Having seen to it that no part of the iris is caught in the wound nor in any manner disarranged, and that the lips of the cut are nicely in apposition, gently sponge away all the loose débris, cortical matter, etc., carefully remove any shreads of fibrinated blood from about the incision with the toilet forceps, and arrange the conjunctival flap. Flow a dropperful or two of warm boric acid solution over the eye and close the lids. Instead of ordering the patient to do this last, the operator will often do well to perform the act himself, usually by taking hold of the lashes, lifting the lid slightly and shutting it. Docile patients, however, may be trusted to do it unaided, but must be warned against forcible closure.

Dressing of the Eye.—A lamina of absorbent cotton, almost as thin as a veil and about two inches square, is made sopping wet with warm boric-acid solution and laid on the lids rather high up (see chapter on "Dressings"), then pulled down into place. In this manner the lashes are smoothed out—not crumpled up in the dressing. Although this may seem a trivial item, it is really an

important one, both for the patient's comfort and for the good of the eye. This first layer of cotton is so thin that when the air is squeegeed out by the fingers, which causes it to adhere evenly, the skin and lashes can be plainly seen through it. The direction of the cotton fibres should be vertical. The boric acid solution with which it is moistened is made from the impalpable powder and should be more than saturated; in other words, there should be an extra quantity of the powder in suspension so that the meshes of the cotton, upon drying, will be filled with it. Gauze or any woven material is not put next to the lids because the twisted threads are more or less hard and press into the delicate skin. Neither is sublimate solution used for moistening the cotton for the reason that it would be found irritating to the lids of many patients. Over the wet cotton, a thick, soft pad of dry cotton is carefully built up so as to give an equal pressure under the bandage at every point. The bandage of netting, wet with boric acid or sublimate solution, is then applied as per the method described elsewhere and fastened with ordinary pins.

Thanks to an idea lately hit upon by Dr. Fullenwider,[1] one of our internes at the Illinois Charitable Eye and Ear Infirmary, never is there any more slipping or displacement of the dressing nor even a chance for the patient to finger the eye beneath the cotton pad. As soon as the bandage is applied, a quantity of flexible collodion is painted on where the folds cross the forehead and cheek and a strip of gauze is laid on the nose and cheek, extending up onto the dressing and similarly smeared, to bar any meddling with the eye on the part of the patient's fingers. The collodion sets immediately, even on the wet netting, and holds beautifully. One of the stiff shields or masks may be tied on, such as Ring's, or the aluminum mould. The latter can be more conveniently and effectively sterilized. As the writer bandages only the one eye, save in exceptional cases, if the shield is for both eyes, a large hole is made in that part over the unoperated eye for the patient to see through. He is told to keep *both* eyes shut most of the time, only opening the free eye when it is absolutely necessary. With a few the emergency will often arise, but with the majority not at all. In case after case

[1] I have since learned that collodion was used in a similar way by De Wecker, of Paris, some years ago.

when it comes to the first dressing, the unbandaged eye will be found to have its lids firmly glued together by old, dried secretions.

After-treatment.—While yet on the operating-table, it is well to give the patient a few parting instructions. He is told that he must keep very quiet in bed for a short time, that it will not be long before he will be allowed to sit up. That he must remember all the while that he is in the hands of his friends, that night and day there is someone within easy call, etc., all of which has the effect of reassuring him, particularly if he can be truthfully informed of the success of the operation. He is warned against stooping or straining, and told that he may turn about, quietly, to assume different positions of lying—on back, side of unoperated eye, and even a little to the side of the operated one, so long as he doesn't press the dressing upon the pillow.

On the journey from the operating-room to the bed, I prefer to have the patient walk to having him lifted—often by untrained assistants—to and from a stretcher or cart. He is helped to a sitting posture on the table, with his feet hanging, then an attendant stands on either side, each with one hand beneath the patient's armpit and the other holding his wrist or hand, when he slides down until he is standing on the floor and is led to his room. There he is told to sit on the edge of the bed while shoes, stockings, and outer dress are taken off by an attendant, being prevented from attempting to help in the disrobing. Having been duly put to bed, he is again assured that there are always near him those whose duty and pleasure it is to answer his calls and attend to his wants.

A moderate amount of light is admitted to the room, and a shaded lamp is allowed at night. To have the privilege granted him of changing his position from time to time as he lies there is a great boon, especially to the elderly subjects, and prevents many complications (one being hypostatic pneumonia) while it causes none. But to be enjoined from moving—told even that he must lie very still—is terrible for the average individual. He gets a notion that the slightest move would be disastrous, and the restraint is torture. All manner of aches and other physical disturbances, including flatulence of the bowels, accumulation of gases in the stomach, etc., are inevitable. Another occasional effect of the operation is to cause retention of urine, and the function of the bladder must be looked after.

If there be retention, a few catheterizations are sufficient to reestablish the function. The subsequent after-treatment is pretty well laid down in the chapter on Consecutive Accidents and Complications.

The First Dressing.—If all goes well, the bandage is left in place for forty-eight hours. This will have given time for normal primary closure or healing of the wound. At the end of this period, no matter how favórable the progress, the eye is inspected. The undressing of an eye requires as much care as the dressing. According to the statement which has already been made (see chapter on Consecutive Accidents and Complications), extrusion or entanglement of the iris is not an infrequent occurrence at the first dressing, and the explanation is as follows:

When one raises the upper lid to open an eye that has been bandaged and the light strikes in, if great caution is not exercised, there is a sudden spasm both of the superior rectus and of the orbicularis, the wound is opened, there is a rush of aqueous, the iris is *washed out*, and when the cut is examined, a prolapse is found. This fact furnishes an argument, therefore, for letting the eye alone if all seems to be going well until time enough has elapsed to insure permanent closure of the incision. This, on the other hand, may be effectively answered by the counter proposition that the mere fact that the patient is uncomplaining, is not conclusive evidence that all is going well. While house surgeon at the Manhattan Eye and Ear Hospital, which was in the days when it was the custom of most operators not to remove the first dressing for six or seven days, I saw complete breaking down of the cornea of a stolid male cataract patient from infection. The poor fellow had been as contented as could be ever since the operation, and although he had been repeatedly asked how the eye felt, his replies were uniformly favorable.

Preventives.—The strongest argument, therefore, would be that we should use the utmost prudence in the handling of these cases, as to the nursing, the dressing, and the examining of them. The patient is made ready for the dressing by a few assurances that the eye is only to be looked at, "no hurting, etc.," and by instruction not to open the eyes until told to do so, never to squeeze, etc. As to the kind of light employed, it may be either soft, diffuse daylight

or focal illumination from moderate lamp flame or gas jet held to the side.

Where practicable, the first dressing should be with the patient in his bed. With strong scissors made for the purpose, the bandage is cut on the side opposite to that of the operated eye. It is then lifted just enough to allow of the fingers being placed upon the edges of the cotton pad which lies upon the lids. This is to hold the pad in place while the bandage is stripped off. After this, if there is the least tendency of the cotton to stick, a little warm boric acid solution is dropped in behind it. The cotton removed, the lids of *both* eyes are gently wiped with a cotton sponge from which the boric acid solution has been so squeezed that the sponge *takes* or *drinks* rather than *gives*. In this way the soiled solution is drawn away from the palpebral fissure and not driven inward through it. At this point, if the patient is nervous, a drop of cocain solution should be instilled, as it will greatly facilitate the inspection. After waiting for he anesthesia the patient is quietly asked to open the eyes, and the thumb is placed on the brow to elevate the upper lid having as a base the rim of the orbit of the operated eye. Now, with the light full on the eye, the patient is told to look down or at an object held for the purpose.

One should not be content with a cursory inspection, but would better look closely, even with the aid of a strong convex lens or the stereoscopic loup, to make sure, as otherwise faint signs of impending trouble might be overlooked. So long as nothing untoward appears no collyria are employed. The eye is dressed precisely as before, and every day thereafter the same examination and redressing are repeated so long as bandaging is necessary, which, in favorable cases, is about one week.

For a day or two after the first dressing, the patient is permitted to sit part of the time in a chair and, at the end of three or four days, to walk about the room. If he has made normal progress and lives near by, he is discharged from the hospital in about ten days, but is kept under observation until the eye is perfectly quiet or free from any redness. When the bandage is left off, a shade is substituted or medium smoke coquilles. The spherical lens that gives the best visual result is fitted in two weeks to a month from the time of the extraction.

ACCIDENTS AND COMPLICATIONS.

The accidents and complications that may occur in connection with extraction are divided into *immediate* and *consecutive*, the former having reference to those that are incident to the operation itself, and the latter to those that may involve the after-treatment. In either instance, when they arise, their origin may be due to one of a number of causes. Lack of skill, care, or experience on the part of the surgeon must stand first in the list of causes. Next in prominence, perhaps, comes want of control and ignorance on the part of the patient. Third, incompetency and neglect on the part of assistants, and, lastly, a whole group of causes for which no one may be held responsible. In this chapter, therefore, an attempt will be made to enumerate the various undesirable happenings and, in so far as possible, to suggest appropriate preventives and remedies; for they all incline to embarrass the operator and to jeopardize his ultimate success.

Reviewed in the order of occurrence they are:

IMMEDIATE.

1. **Accident.**—*Over or prolonged cocainization*, causing drying and exfoliation of corneal epithelium, bleeding from conjunctival flap, hypotonicity of the globe, collapse of the cornea, and delayed union of the lips of the wound.

Preventive.—Use only two to four drops of a 4% solution. Keep the lids closed and covered with wet cotton between whiles, so as to prevent drying of cornea, and make the operation under the primary effect of the drug.

Remedy.—Defer the operation until another day or the next day.

2. **Accident.**—*Touching the eye with the fingers.*

Preventive.—Obvious.

Remedy.—Douche the eye copiously with warm boric acid solution.

3. **Accident.**—*Allowing the knife or any instrument to touch cilia, skin or any object other than that desired.*

Preventive.—Obvious.

Remedy.—Immediately either take a fresh instrument or cause that one to be again disinfected. Or, if the accident happens while using, as knife, for instance, try to keep the portion contaminated from entering the eye.

4. **Accident.**—The serio-comic dilemma of *finding that the knife-blade has been inserted upside down.*

Preventive.—Obvious.

Remedy.—Knapp[1] advises that, without withdrawing, the knife be simply turned 180° on its long axis, thus reversing the position and continuing the section. He states that the accident has happened to him four times and that there has never been any reaction seen from it. He doesn't say that he resorted to this redress in each instance, but such is the inference. Now, every man is not a Knapp, and the writer would, in view of this accident, counsel postponement of the operation for at least twenty-four to forty-eight hours. Given a deft hand and a very narrow knife, this feat of turning the blade might be attempted but, having accomplished it, if the anterior chamber is found empty, it were better to desist for the moment from pushing the operation further.

5. **Accident.**—*Engaging the point of the knife in the iris just after making the puncture.*

Preventive.—Depress the handle immediately the point enters the anterior chamber, so as to clear the iris.

Remedy.—Withdraw the knife, without changing its direction, just enough to release the point, and continue.

6. **Accident.**—*Starting the counterpuncture too far back or too far forward.*

Preventive.—Better light, and bearing in mind that owing to the refractive media through which we see the blade, it *seems* to be nearer to us, or higher, than it really is.

Remedy.—Same as for No. 5.

7. **Accident.**—*Pressing the jaws of the fixation forceps into the globe during the making of the cut*, forcing out the aqueous and causing premature emptying of the anterior chamber.

Preventive.—Rest the little finger of the hand that holds the forceps firmly on the patient's nose or cheek and do not altogether lose sight of what that hand is doing, else not only is this accident

[1] Norris and Oliver System, p. 800.

more probable, but one's grip of the forceps is apt unconsciously to relax and leave the globe free to turn. To insure firmness, the bite of the forceps should include the episcleral tissue.

8. **Accident.**—*Rising of the iris in front of the edge of the knife.*

Preventive.—Attention to fixation forceps. Avoidance of all unnecessary alterations in the cutting plane which pry open the incision and spill the aqueous. See to it at the time of making puncture and counterpuncture that the blade lies *flat* upon the iris, as to turn the edge backward, risks to engage that membrane.

Remedy.—Seeing that the iris is overlapping the knife, sometimes a slight turning forward of the edge or lightly lifting the entire instrument will free it, albeit the first maneuver causes the incision to end somewhat further within the limbus than was intended. If these fail, nothing is left but to cut boldly ahead as if nothing were n the way. The result may be a buttonhole, a clean coloboma, or some irregular form of iridectomy. In any case make sure that there remains neither pupillary bridge nor dangling fragment, before proceeding with the operation.

It is not humiliating for a surgeon to confess that he does not always accomplish just what he plans or desires in this operation, whatever his skill and experience. In this connection, for example, an exceedingly shallow anterior chamber may thwart the making of a classic incision. Again, an unruly or restive patient may baffle the most practised hand.

9. **Accident.**—*Splitting of the cornea.* The best form of corneal incision has already, to a certain extent, been dwelt upon. Suffice it here to reiterate that the best apposition is obtained and the kindliest healing assured where the outer and inner wound opening are not widely separated and where the summit of the incision is neither very far within the limbus nor decidedly back of it. Those who have not the good fortune to operate frequently for cataract are prone to magnify the snares and pitfalls, hence, in making the puncture, dreading to become entangled in the iris, they depress the handle of the knife too soon and, in pushing the point further, they observe a dimple appear in the cornea over the blade and then realize that they are splitting that membrane.

Remedy.—Since the anterior chamber has not been entered, withdraw the knife completely and begin over.

Then, in making the counterpuncture, they have painfully in mind that illusive refraction of the cornea and aqueous, and make it too high up. Continuing, so very solicitous are they lest the iris "falls in front of the knife," that they steer far above it and again split the cornea on emerging. Thus is made a long "wound-canal" which greatly involves matters. To begin with, its inner opening is likely to be too narrow for the ready passage of the lens, while the long projecting nether lip forms a shelf which interferes with the work of attending to iris and cortex. These attenuated lips, moreover, impair the healing quality of the wound because they are, of necessity, poorly nourished—leading to gray infiltration, necrosis, "grooving," nests for bacteria, and, ultimately, broad and contracted cicatrices.

10. **Accident.**—*Including with the section rather large, lateral, conjunctival flap.*

Preventive.—Observe the rules already given for the fixation of the globe, though if it should occur pay no attention to it so long as the incision is not too far back. It merely increases the chances of the following:

11. **Accident.**—*Bleeding into the Anterior Chamber.* The presence of any considerable hemorrhage in the anterior chamber at this stage is objectionable because it obscures the field of subsequent operation.

Preventive.—Avoid too large a conjunctival flap and too prolonged cocain effect.

Remedy.—Flood the eye gently with warm boric acid solution and stroke the cornea softly with the back of the Graefe spoon, applying, the while, a pointed cotton sponge to the incision, and the blood will usually come out. If necessary depress the posterior lip of the cut, or insert the tip of the spatula while stroking upward with the spoon. If this does not accomplish the removal of the blood, a flattened canula attached to a bulbous aspirator may be used. The cannula should be sterilized in the flame of a spirit lamp, as it is very difficult to sterilize a small-bored instrument by other methods. It is better surgery, however, to leave a little blood in the anterior chamber than resort to the cannula, for every additional instrument introduced into the eye adds to the danger of infection.

12. **Accident.**—*Air in the anterior chamber.* After introducing

the cystotome, we sometimes become aware of a bubble of air in the anterior chamber. This comes from lifting the corneal flap, while introducing the instrument, and causing a vacuum beneath. The same accident may occur through inserting the forceps for iridectomy. It may be prevented by gliding the aforesaid instruments in more deftly.

Remedy.—A few, gentle, upward strokes of the back of the spoon upon the cornea will usually drive it out. Though if some of it be left behind it is not supposed to be harmful, as it is soon absorbed. However, in an otherwise perfectly normal extraction performed by the author, in which this accident occurred, the operation was followed by panophthalmitis, although the air was immediately removed in the manner just described. Therefore it appears safer to irrigate the anterior chamber after such an accident, in order to thoroughly wash out any infection introduced by this bacteria-laden bubble of air.

13. **Accident.**—*Failure to make capsulotomy* comes of either a dull-pointed cystotome or of so depressing the handle that the convexity of the lens prevents contact of the point with the capsule. Or the capsule may be too tough, in which case, particularly, if the zonule is weak and the vitreous is fluid, the cataract, capsule, and all will simply be depressed beneath the instrument or move with it in attempting to make the cut, no matter how sharp the cystotome.

Through too much grinding the cystotome often loses it proper form or model and becomes an insignificant remnant—an anomaly—and then it should be discarded. The surgeon should be as exacting as to shape and keenness in the cystotome as in the knife.

Too much caution in making the capsulotomy cannot be exercised. Actual pression is inexcusable. There is no step of this very delicate operation of extraction that so strongly exacts a fine sense of touch. If one does not sense nicely the force of the scratch, the zonule is torn and the ciliary processes are lacerated. By watching closely, one may in most cases be assured of a complete incision in the capsule by seeing the cataract suddenly rise. Yet, as this is not always apparent, he may be unaware of his failure until, in attempting to express the lens, that body refuses to respond to the wonted pressure.

The remedy consists in again going through the act, this time being more careful as to the condition and manipulation of the instrument.

It may chance in essaying the capsulotomy that the cataract is observed to follow the movements of the cystotome. This indicates a tough capsule or a ruptured zonule or both, and one must be extremely wary in the delivery of the lens lest there be escape of vitreous. If it is quite evident that the capsule cannot be cut sufficiently without luxation of the lens, recourse may be had to the capsulotomy forceps. If these extract only the capsule and not the cataract with it, the open sharp hook would be the writer's preference as the traction instrument to use. First, however, unless the pupil behaved unusually well, it were safest to make iridectomy.

14. **Accident.**—*Inadequate wound opening.* The causes of this have been previously enumerated. Like the incomplete cystotomy, the operator does not always realize the presence of it until the lens, while presenting in a normal manner, yet fails, even with pretty firm pressure, to advance. The signs of an insufficient section are unmistakable, however, as soon as the spoons are applied and the wound yawns, for then the small inner opening is brought to view, against which the lens bumps ineffectually, and to unduly force its exit would be most prejudicial, as even should the effort succeed, the iris and cornea would be wantonly bruised and the cataract would probably be shot out by an explosion of vitreous.

The fault may be one of several. The **remedy,** however, is to enlarge the incision, which may be done either with sharp-edged and blunt-pointed knife (Desmarres) or with scissors. The smallest blunt-pointed strabismus scissors, curved on the flat, are excellent for the purpose.

15. **Accident.**—*Rigidity of the pupil.* This rarely occurs if there has been fair mydriasis when the operation was begun. The pupil does not always respond to the atropin. In any event, if the sphincter does not yield to rather prolonged pressure—moderately applied, for there is no need to hurry—perhaps the wisest alternative is to make a small, one-snip iridectomy which comprises little more than the sphincter itself. Knapp recommends first trying to push the iris back over the lens with the wire loop; and Panas practised snipping of the pupillary border with the De Wecker

forceps-scissors—both are masters in their art and wholly worthy of emulation.

16. **Accident.**—*Erratic behavior of the lens.* Cataracts with small, hard, or discoid nuclei, especially those with degenerated liquid cortex and frail zonules or shrunken lenses, are apt to prove capricious when we try to drive them out. One of their peculiarities is to become agglutinated to the posterior surface of the cornea, as if by suction, and so long as the lower spoon is pressed below the cornea, the lens will not budge. If the condition be not recognized at once and tactics changed, a gush of vitreous is sure to follow.

The remedy is merely to slide the spoon up onto the cornea, dislodge the cataract, and push it out.

Another freak of such cataracts is to slip up behind the iris, or even where iridectomy has been made the upper edge of the lens may lodge behind the incision. This, too, exposes to turning over of the lens and vitreous escape.

The remedy which has always served the writer in this emergency is to push the crystalline down by means of the little iris spatula, then to proceed with the delivery in the regular way. Others favor the cystotome, but the spatula is easier of insertion and quite effectual. Failing with this, the open sharp hook is the thing.

Again, there is a class of pasty, sticky cataracts that, in spite of an ample incision, will hang and choke the opening, and if urged too strongly may pop out suddenly, entraining loss of vitreous.

The remedy is, while the operator applies just enough force to hold the mass well up, for a handy assistant to dig the cystotome or sharp hook into the edge and deliver it by a sort of sidewise rolling motion. Or the operator himself may do this with the edge of one spoon while holding the lens up by pressure with the other. It only remains in this connection to discuss that rather startling vagary,

The Sinking of the Cataract into the Vitreous.—Fortunately, a very rare complication, but, when met, the operator must be prompt to act or all is lost. I have seen one of the most skilled and tactful ophthalmic surgeons the world has ever produced fail utterly to deliver such a recalcitrant lens, and have seen others, almost as proficient, reduce the globe to a hopeless wreck when confronted with the accident. One of them placed the left thumb behind the

incision and the right, beneath the cornea and then approximated them, expelling cataract, vitreous body, and all. The cause of this occurrence is usually the complete tearing away of the zonule in an eye with liquid vitreous.

Various instruments have been used and advised for reclaiming the lens under these conditions, as also for delivering it when the vitreous is presenting or escaping; these include almost all the spoons, hooks, loops, and scoops from Daviel's down. The fenestrated spoon of v. Graefe, the delicate wire loops of Weber and Snellen, and the vectis of Taylor, each of them has stood its advocates in good stead. The writer's preference, however, is for a modification of the sharp hook, commonly attributed to Tyrell and by some to Jaeger, but originated, I believe, by Beer. This surgeon designed and employed the instrument as a tenaculum to draw out the iris in the operation of iridectomy. The modification consists merely in making the hook much less curved than is that of the regular pattern. Instead of being bent back upon itself, like a button hook, it is about the shape of a miniature strabismus hook (v. Graefe's model), only, of course, sharpened. This straightening out of the bend is to enable the point to catch readily in the lens substance, whereas the highly curved form might slip off (see chapter on Instruments). With such an instrument, insinuated flatwise at the opening, pushed downward behind the cataract without turning, until the point is opposite to that body, then turned forward and thrust into it, it is surprising how easily, and with what slight disturbance of the vitreous, the refractory cystalline may be slid along the anterior wall of the globe and out at the incision. Its displacing effect, as compared with any kind of spoon or even with the wire loop, is practically *nil.*

In the event, however, of the lens turning turtle and dropping entirely out of sight, the sharp hook should not be plunged to the very bottom of the vitreous chamber, for fear of its fouling the inner tunics of the globe. If the cataract must be "fished" for—the depths of the vitreous dragged, as it were—then a delicate wire loop would be the safer instrument to employ.

A few ophthalmic surgeons of great repute, among whom may be mentioned Snellen,[1] advise the bandaging of the eye into whose

[1] Graefe-Saemisch Handbook, Operationslehre, p. 47.

vitreous the lens has sunken and waiting twenty-four hours, when, as was often the case after depression, the lens will probably have returned to its place. The wound is then reopened with the spatula and the cataract extracted with a traction instrument, either loop or hook.

17. **Accident.**—*Presentation or prolapse of vitreous.* When this occurs in the uncomplicated cataracts, it is traceable, as a rule, to one of two causes—spasm of the orbicularis, squeezing on the part of the patient—or to some fault in the technic of the operator. Large or prominent eyeballs are peculiarly liable to vitreous loss from "nipping" or from pressure of the speculum, for obvious reasons. Another cause, already alluded to (page 111), is found in the bar of the old-style lid-holder. Still another, the reclining posture of the patient in a chair, is said to be attended more often by this accident than the recumbent one on a table.

The preventive for the first is to see that the brow is properly supported or he blepharostat held up. Inexperienced operators would do well to have a trained assistant hold the lids apart with retractor and fingers, dispensing with the blepharostat.

When the blame, if it may be so termed, rests with the surgeon, it may be laid to inattention or inadvertence in some step of the operation, such as too great pression upon the fixation forceps or upon the cystotome, to insufficient opening of the capsule or cornea, to cutting beyond the equator of the lens in making the capsulotomy, etc. It may also happen in our efforts to remove the cataract remains after expulsion of the more consistent portion of the lens, which will be treated of later. We have often heard eye surgeons declare that they did not mind a moderate loss of vitreous, and we have often seen apparently permanent good sight, etc., in an eye that had lost vitreous in the extraction. Nevertheless, it is a dangerous contingency and one most scrupulously to be avoided. Not the least serious nor the least common of its sequelæ is extensive detachment of the retina and this has a way of creeping slowly and stealthily, so that months or even years may elapse before the worst comes.

Remedy.—Whether the vitreous is only on the point of escaping or is actually in the act, the speculum must be removed at once and left out. For the subsequent steps of the operation, the upper lid

should be held back by the finger or by the Desmarres retractor. It is best to press the lid up tightly beneath the roof of the orbit with the retractor in order to discourage any contraction of the orbicularis. If the lens is still in the eye, whether or not the capsule has been incised, it should be delivered with a traction instrument (the sharp hook already referred to).[1] Any attempt to express it would only lead to further loss of vitreous. The cataract having been extracted, the protruding vitreous should be cut off close to the incision by means of delicate curved scissors, and the iris, if prolapsed, should also be cut off, as to try to replace it would most likely entail another gush of vitreous. If practicable, all vitreous remains are to be flushed out of the conjunctival sac by copious warm irrigation, as they strongly invite infection. The sooner the wound can be put in fair shape and the eye dressed, the better. Both eyes should be carefully bandaged, and the patient should be kept very quiet for a few days. This subject will be again considered under Extraction of Complicated Cataracts.

18. **Accident.**—*Extrusion or entanglement of the iris at the incision* is usually caused by a sudden out-gush of aqueous. This escape of aqueous is most often produced by pressure upon the globe from without, either by the operator with his instruments or by the patient with his orbicularis It is often quite an unavoidable occurrence. I there is an extensive prolapse, especially if the iris is torn, it were best to excise a small portion at once. If there is merely a catching up of the membrane or only a slight extrusion it may be reduced. Before setting about it, it were well to pause, again closing the eye, and covering the lids lightly with the wet cotton. When the lids are opened, it is not uncommon to find that the iris has replaced itself. If not, a few drops of he boric acid solution are applied, and w th the spatula, wet with the solution, the wound is softly patted, or, as advsied by Knapp, the globe beneath the cornea is pressed upon in such a way as to cause the wound to

[1] I have more recently arrived at the conclusion that there is a less radical and a better way to deal with some of these cases of *vitreous previous*, if one may be allowed the expression. Take for instance, one of attempted simple extraction in which the vitreous comes before the lens. Instead of resorting to the policy of at once delivering the cataract at any price, stop the operation, put the eye in the best condition possible, and apply the dressing. Then, by subsequent intervention, with the patient in narcosis and with the help of the Angelucci fixation of the globe, there may be a much better chance of saving the eye and of restoring the sight.

gape and drop the iris from its lips. Failing in this to restore it, the spatula is introduced edgewise at the incision, with a sort of slicing motion, which corrects the middle portion. Then, if there be still any caught in the angles, they are gently poked back into place with the end of the instrument.

19. **Accident.**—*Collapse of the cornea.* If this membrane is very thin and the subject is aged, especially if much cocain has been used, as soon as the lens is expelled, the convexity of the cornea becomes reversed, a more or less deep concavity taking its place. This hampers the manipulation of lens remains and dealing with the iris, and if *lavage* of the anterior chamber has a place, this must be it. There could, at any rate, be no objection to the filling of the anterior chamber with warm normal salt solution merely to facilitate maneuvers relative to the cortex and iris. This is not a serious casualty, and usually all that is necessary is simply to wait a few minutes for the anterior chamber to refill. The eye should be protected by a piece of wet cotton in the meantime.

20. **Accident.**—*Expulsive or retrochoroidal hemorrhage.* This deplorable calamity, which is always fatal to the sight and usually to the globe, though it comparatively seldom befalls, comes to the experienced operator and to the tyro alike, and without warning. He, in whose practice it has never occurred, has much to be thankful for. The writer is one of these lucky individuals, for with a total of more than 1,200 extractions, and a still greater number of iridectomies, he has yet to meet with this catastrophe.[1] The predisposing cause is usually degeneration of the vascular system (arteriosclerosis) and the immediate cause is violence to, or straining of, the walls of the vessels through the opening of the globe, causing a rupture. The two long posterior ciliary arteries, because of the manner in which they pierce the sclera, and owing to, the directness of their blood columns, are peculiarly liable to this form of hemorrhage. Most often the break occurs just within the sclera, and it is supposed to be produced by the dropping away of the vitreous after the incision is made. Glaucomatous eyes are especially subject to it, and, in these, it is as apt to follow iridectomy as it is

[1] Since writing the above I have had two such accidents—one 48 hours after an extraction, the other immediately attending an iridectomy for glaucoma.

extraction. It can be classed among both the immediate and the consecutive accidents.

If the bleeding takes place during the operation, the first sign of it is spontaneous gaping of the wound. Then, if the source of it is far back, either the lens or the vitreous appears. At the same time the patient complains of great pain and utters a series of groans that are of themselves distinctive of his misfortune. This groaning may, indeed, be the first warning. Whether it be lens or vitreous that first escapes, it is soon followed by a gush of blood. If the rupture is well forward, the blood may escape in advance of the other structures. Often retina and choroid are eventually expelled. So great is the force exerted by the accumulating hemorrhage, that once, for example, while an onlooker at an operation of iridectomy for glaucoma, I saw a large, firm crystalline (transparent) forced out, entirely intact, through a rather small keratome incision. Although in order to make its exit, it had to elongate, like an ameba, yet it never halted for an instant. Patients with palpable signs of arteriosclerosis should, in view of the possibility of such hemorrhage, be handled most gingerly when it comes to extraction. Especially should one guard against sudden escape of aqueous, undue pression with fixation forceps, spoons, or cystotome, and pulling upon the iris.

Prevention.—It is prevention or nothing. It is safe to conclude that most of the victims of expulsive hemorrhage after extractions and iridectomies are persons with degenerated vascular systems and abnormally high blood pressure. Even normal arterial tension is dangerously great for such operations with certain forms of degeneration. What more rational, then, along with other preparatory measures, than to make routine practice of testing the blood pressure. If high, say above 140 mllm., and the patient's age and general signs make the situation at all precarious, a course of treatment could, with impunity, be given, calculated to lower the pressure, at least for the few critical days. Among the measures to be resorted to are blood-letting by venesection (see chapter on "Paraoperative Technic"), free saline purgation, veratrim viridis, sodium nitrite, etc.; though such medication is of doubtful efficacy in advanced arteriosclerosis. Continual tests are made with the sphygmomanometer to ascertain if the treatment is of any avail. When sufficient

time can be had before the operation, the prolonged administration of the iodids and the making of a preliminary iridectomy are advisable. The extraction should follow within a few days or a week of the iridectomy, while the intraocular tension is still low. Other precautions are narcosis—gas and ether, or, if everything is favorable chloroform—for the operation; and sedatives, such as codein, chloral, cocain, or morphin, immediately before and after the operation, and the avoidance of mydriasis. Both eyes should be snugly bandaged after the extraction, a protective mask put on, and the patient be under the constant surveillance of a trained nurse or trusted attendant.

Remedy.—There is little that can be done. Remove all extraneous pressure, cut off the vitreous, if prolapsed, coapt the lips of the wound as well as possible and apply a compressive bandage to both eyes. Give the sufferer a dose of morphin and put him to bed where he should be placed in a half-reclining posture. The ultimate lot of the majority of these eyes is enucleation or atrophy of the globe.

21. **Accident.**—*Yawning or upheavel of the lips of the wound.* In rare instances this is apparent or else there is a tendency for one lip to override the other—*vicious coaptation.* The former occurs without actual presentation of vitreous. De Wecker asserts that it is sometimes the result of puncture of the hyaloid fossa, in attempts to rid the eye of lens remains, and is due to a rising intraocular pressure which may be detected by palpation, the resistance actually increasing under the finger. Another symptom is the pushing upward of the iris. He warns against making further pressure on the globe, as it would precipitate escape of vitreous and advises immediate instillation of eserin solution and bandaging.

ACCIDENTS, ETC., CONSECUTIVE TO EXTRACTION.

Prolapse or Incarceration of the Iris.—This is a casualty that sometimes intervenes between the operation and the firm healing of the incision, and is, in most instances, produced by some force that causes the wound to open, such as coughing, sneezing, straining, striking the bandage over the eye with the hand or against some object or the impact of a faulty dressing. It is by some also

attributed to swelling of abandoned cortex. So long as the lips of the wound are closed, and before they have actually united the anterior chamber is filled with he aqueous humor, at which time comparatively slight pressure is sufficient to cause a parting of the lips, when the aqueous gushes out, carrying the iris with it. The patient is then often, though not always, aware of a sudden change in the feeling of the eye, and that organ, from having been relatively

FIG. 240.—Slicing movement with spatula.

comfortable, becomes uneasy. There is pain or a feeling as if a foreign body had gotten into the eye, and the dressing beneath is found moist from lacrimation. Objection has often been made to mydriasis after simple extraction, on the ground that it favors prolapse of the iris. With this the writer does not agree. Until the anterior chamber reforms the pupil remains contracted. After closure of the wound the mydriasis returns. Now, should the wound suddenly reopen, the iris, with pupil enlarged, will

offer less resistance to the quick outrush of the aqueous than if its pupil were small.

These are conditions that demand immediate attention, i.e., removal of the bandage and inspection of the eye. If the iris be found in the wound and is sufficiently free to admit of the procedure, the eye is cocainized, the iris is replaced with the spatula, as described a few paragraphs back, and eserin instilled (Fig. 240). If this be impracticable the only alternative is to make an iridectomy. Indeed, in but few instances are we allowed any other. Now and again when cicatrization is pretty well established, a small hernia or projection of the iris is noticed, for which a searing by means of a small galvanic electrode proves a most efficient remedy. A recent hernia may sometimes be manipulated with smooth-jawed forceps and spatula, till thoroughly mobilized, sn pped off, the iris replaced, the opening seared w thin the galvanocautery, and eserin instilled; though myotics, as a rule, are of little avail.

Many times, undoubtedly, this rush of aqueous is induced by something which takes place at the first dressing of the eye, most often by pressure that is brought to bear upon the lids in first open ng them, either by the physician's thumb or by the patient's orbicularis (see After-treatment).

H. Beckles Chandler, of Boston, contributes an article to Knapp's Archives for January, 1904, entitled, "Report of 312 Cases of Cataract Extraction with a Small Peripheral Buttonhole of the Iris." This opening is made by excising, by means of small iris forceps, whose teeth "are at the tip end," "and scissors whose blades are very thin," a circular piece of the iris, one millimeter in diameter and "as near the root of the iris as possible." The corneal section is exactly in the sclero-corneal junction and the buttonhole is made *after* delivery of the lens. According to the author, it serves the double purpose of a sluice-gate for preventing prolapse and of a vent through which to milk out the cortex that slips up behind the iris. In the 312 extractions reported, there was iris prolapse in but four, and two of these were "the direct result of violence."

It has long been a mooted question as to whether or not iridectomy really tended to prevent prolapse and incarceration of the iris. Panas reports iris prolapse in 5 per cent. of simple extractions. Becker says this accident more frequently follows the combined than the simple

operation, and gives statistics based on an anatomical examination of 17 eyes after simple extraction, in which iris tissue was found in the wound three times, or 18 per cent., while in 15 eyes examined after combined extraction it occurred 10 times, or 60 per cent. Köllner reports 289 incarcerations following 1,284 combined extractions in the clinic of Prof. Michel, of Berlin, i.e., in 22 per cent. of the cases. The wide variation in these reports may be accounted for in part by some observers basing their deductions on the gross findings in the living subject, while others resort to careful examination of the enucleated eye, as did Becker. Differentiation must also be made between those cases of prolapse and incarceration following the *combined extraction* and those occurring after extraction subsequent to a *preliminary iridectomy.*

Cystoid cicatrix is one of the very late after-complications following cataract operations and iridectomies, where there was healing of the wound with the iris included. A fold of iris protrudes in the form of a hernia or a small sinus leading into the anterior chamber remains beneath the conjunctiva where the iris is entangled, and an ever increasing sac of aqueous is the result. The first-mentioned form is most dangerous, as nothing intervenes between the external world and the interior of the eye but the attenuated and degenerated iris, which really amounts to a partial staphyloma anterior. Then let there be acquired a septic condition of the conjunctiva or of the lacrimal canal, and infection with panophthalmitis is likely to occur at any moment. Besides, the iris is drawn more and more into it, thus interfering with vision, and the growing vesicle becomes inconvenient and unsightly.

The galvanocautery, repeated a number of times if necessary, and a long continued compression bandage is the best remedy. If the second-mentioned variety is in question, the cyst should be freely incised, the underlying fistula sought and well cauterized.[1] Another sequel of these complications is high or incorrigible astigmatism. Something is to be hoped for in the experimental incisions as a remedy for this defect.

Retroversion or involution of the iris is another rare phenomenon after extraction. This consists in a turning backward of a portion or even all of the pupillary border. Most often it is the

[1] Berry, Oph. Review, xxi, 88.

upper portion, which gives much the appearance of a coloboma. It is particularly liable to occur after escape of vitreous during the operation. The shrinking back of the extruding process of that body pulls the iris back with it, or in some cases actual connective tissue bands form, by which the iris becomes tied, as it were, to the vitreous. Once, in a case of soft cataract where I had made discission, the entire iris disappeared, simulating aniridia, and it required several instillations of eserin solution to reinstate the membrane.

Iritis and cyclitis, when encountered in an eye after cataract operations, do not differ materially in character from these inflammations when arising from other causes. Indeed, the same predisposing causes are often operative in both instances. Owing to the changed relations, however caused by the operation, and to the absence of the lens, etc., these diseases in aphakial eyes present phases that are not found under other circumstances. One of these concerns the peculiar distortions and the closure of the pupil. The disease may vary in severity from an insignificant localized inflammation and a tiny synechia at a spot where there has been a minute rupture of the sphincter, of the pupil, through all grades of iritis, synechia posterior, occlusion and closure of pupil, cyclitis with glaucoma, or general uveitis with phthisis bulbi; or even sympathetic ophthalmia may result.

These processes are excited by violence to the iris and ciliary body in some part of the operation, by the iris getting into the incision, by the implantation of microbes, etc., but most often, perhaps, by abandoned lens remains. And just here, another word as to the importance of freeing the eye of all cortical residue, as nearly as possible, at the proper time of the operation. The most experienced and observant ophthalmic surgeons all agree as to their pernicious effects when left in any quantity. In attempting, therefore, a simple extraction, when one is convinced that certain otherwise inaccessible cortex lurks behind the upper portion of the iris, an iridectomy it imperative. The most treacherous, of course, are the transparent remains that do not show any opacity until a day or two after the operation, as, for example, those from the nuclear cataract, that will cling to the capsule, especially the posterior half and elude the best directed effort. Then, by their swelling, crowd-

ing, etc., start the mournful train of symptoms that so often prove the bane of the operator and the undoing of the eye.

The treatment that is best for these same affections in general is also best for these. Locally, atropin, hot applications, leeches to the temple, subconjunctival injections of salt or mercurial solution, etc. Internally, calomel, salicylates, pilocarpin hypodermics, etc., and attention to any predisposing dyscrasy. If there is any amount of lens matter in the eye, it should be seen to that the pupil does not contract, if it is in the power of atropin or any other mydriatic to prevent it. A considerable quantity of fluffy or flocculent lens remains is well tolerated by the eye and is not to be feared.

Infection—suppuration—"puss-wound" of the Germans— may be either *endogenous* or *exogenous*, and the exogenous infection may primarily involve either the corneal incision or the anterior chamber or both. Under prevailing methods and with favorable surroundings, this dreadful contingency is infrequent. A surgeon may now make two or three hundred consecutive extractions without once encountering it. Yet, again, it may be his fate to have it occur in several cases in quick succession. With properly prepared patient and paraphernalia and with a normal tear canal and conjunctiva, the source of the infection is always a mystery, and we may thank our stars that we are so often spared the unforeseen evil. Anatomical and bacteriological examination have shown that grave forms of endogenous infection may be due to capillary microbian embolism of the vessels of the retina and choroid and that these may contain the same bacteria that have produced a general infection. Surgical interference seems, under these circumstances, to render susceptible to infection eyes that otherwise would be immune.

Owing to the nature of the poisoning agent, or to the treatment instituted, or, it may be, to the qualities existing in the eye or the system, the suppuration will be of every grade from that which will terminate with slight sloughing of the lips of the wound, leaving merely a broad cicatrix, on through a middle grade, affecting all the structures anterior to the ciliary body, to that so overwhelming in its virulence as to practically destroy the eye in a single night. It seems that vitreous humor in the wound is, of all things, the most inviting to pygenic bacteria.

If present, the trouble usually begins within twenty-four hours, and hardly ever beyond seventy-two hours from the time of operating. Bach says that infections appearing earlier than forty-eight hours after the operation come from the instruments. Dor states that infections coming after forty-eight hours and before seventy-two hours are from the conjunctiva and not from the instruments. Most infections occurring after four days are probably endogenous. At the onset of the infection generally, not invariably, there is pain, lacrimation, etc. Inspection of the eye shows puffiness of the lids, edema of the conjunctiva, mucous or mucopurulent discharge, gray softening of the lips of the incision, and, if the process has got well under way, yellowish streaks leading from the wound into the deeper parts of the globe, and a turbid, greenish glimmer of the iris. A rarer form of infection is that which originates in the iris or vitreous, and comes somewhat later than wound suppuration; indeed, before its onset healing of the incision has generally been effected. The origin of the poison in these cases is believed usually to be endogenous. In spite of the most vigorous measures, the usual end of a rank infection is panophthalmitis. Now and then, by the very early recourse to energetic treatment, however, not only is the globe saved, but useful sight as well. As our science advances, the aspect of these cases grows less discouraging, just as their occurrence becomes less frequent, and one is not expected to give up, as formerly, but, on the contrary, to make a desperate fight for it in every instance.

For the *prevention* of infective processes after operations that necessitate opening of the globe, De Wecker conceived the idea of making peritomy, loosening up the conjunctiva and putting in a purse-string suture, making the extraction (or other operation), then drawing the conjunctiva together, thus covering with it the entire cornea. This procedure has been practised lately by Ellet, of Memphis. Kuhnt, of Königsberg, for the same purpose, loosened the conjunctiva only around the upper half or two-thirds of the cornea, drew it down and sutured it to the episcleral tissue at either side opposite the center of the cornea. Gifford, of Omaha, makes use of the purse-string suture surrounding the entire cornea and ending below, but dissects up only that encircling the upper half. After the cataract operation, he ties the suture which pulls the conjunctiva effectually over the incision.

Aside from the preventive measures already enumerated, mention must be made of the internal administration of potassium iodid. L. Dor, before the French Congress of Ophthalmology of 1901, reported experiments upon animals whereby he had demonstrated that one to two grams of potassium iodid given the day before the operation had power to prevent all inflammatory phenomena in eyes inoculated with cultures of the staphylococcus pyogenes aureus in doses sufficient to produce panophthalmitis in the eyes of control animals. Certainly, a simple and harmless prophylactic which could easily be added to the routine of preparation.

Treatment.—Calomel, salicylates, milk-punches, quinine and strychnin, leeches to the temple. Locally, the hourly (night and day) moderate irrigations of very hot 1/2000 or 1/1000 bichlorid solution, immediately followed by copious ones of hot boric acid solution. Subconjunctival injections of the salts of mercury and the injection of antiseptics into the anterior chamber, etc. I have recently seen such an eye apparently saved by the deep (subtenonian) injection of the cyanid of mercury 1/1000, 8 to 12 minims at a time, every twenty-four or forty-eight hours. Cautery of the incision is practised by some after reopening it. This is followed by irrigation of the anterior chamber with mild antiseptic solutions. French surgeons are partial to the use of methylene blue, both internally and externally, in these infections, but the practice has never been popular in the United States. Haab introduces into the anterior chamber soluble rods impregnated with iodoform.

Filtration Chemosis.—In those cases where the corneal flap has included some portion of the conjunctiva, the incision in the latter occasionally unites firmly before there is healing of that in the underlying cornea, hence, if the aqueous now escapes, it will accumulate between the sclera and the conjunctiva. The opalescent, edematous swelling which results, is of unmistakable appearance—being free from redness, and changing its location in obedience to the law of gravity. The progress of the eye is not seriously interfered with, and no special intervention is called for.

Iritis, cyclitis, and glaucoma, secondary to the extraction, have already been considered (see p. 519).

Late Wound Healing.—This phenomenon is recognized by the persistent or intermittent absence of the anterior chamber for

several days, or even weeks, after the operation. The delayed union is most likely the result of shreds of capsule or iris, particles of the lens, clots of blood, or portions of vitreous that lie in the cut and prevent union. It has been thought by many to be one of the causes of secondary glaucoma[1] through entrance of the corneal epithelium into the anterior chamber, and there piling up in the angle of the iris; and by causing adhesions between iris and cornea, etc. It also leads to the grooving or guttering of the wound. When discovered the danger from suppuration is usually passed, the thing needful being to keep both eyes carefully bandaged, to enjoin quiet and rest, to prevent prolapse of the iris, and, in most cases all will be well. The least movement of the globe causes a "working" of the iris toward the incision, and a crowding against the trabeculum, or blocking of the iridic angle. When iridectomy has accompanied the extraction, this working of the iris results in the swollowing up of the pillars of the coloboma by the inner lips of the corneal wound, and in adhesions between iris and cornea.

The eye should be carefully inspected with a view to the possible discovery of the cause and the removal of the non-healing element. If no obstruction is detected and the leakage persists, a spatula may be passed through the wound with a slicing motion, provided the union has not progressed too far, and the eye copiously douched with warm boric solution. Iridectomy has often been resorted to with the effect of causing immediate closure. Just how this acts, I am not prepared to explain. Arlt thought that the constant outflow of aqueous in delayed union was a means of preventing suppuration, and rather welcomed the accident, as have others since.

Striated Cornea, or as it has also been named, *striped keratitis* (Heymann), though it can hardly be called an inflammation, refers to a singular appearance presented by the cornea (noticeable at the first dressing) after certain extractions through an inadequate incision and one whose summit was rather far within the limbus. The distinguishing feature is a great number of fine gray lines—a true striation—extending downward varying distances from the cut. They have been thought by C. Hess to be wrinkles in the posterior layers of the cornea due to the stretching and rubbing of the flap incident to the violent delivery of the cataract. De Wecker

[1] Meller, v. Graefe's Arch., lii 3, and Ophth. Review, Nov., 1901.

considered the appearance to be the result of simple retention of the lymph in the channels adjacent to the wound due to traumatism and not to imbibition of liquid or infiltration. He looked upon it as a quite innocent condition, exceping in the event of an accompanying violent iris reaction, when the vertical striæ are seen to be crossed by a horizontal set. If all eyes upon which extraction has been made were closely scrutinized with a magnifying glass under strong focal illumination, this condition would, to a degree, doubtless be found in a large number. The treatment consists only in ordinary care and bandaging. Dionin is usually indicated.

Glaucoma, secondary to the operation, is not a frequent sequel, but is said to follow in 1% after the combined operation, and less often after the simple. Aside from predisposition to the disease, among the local exciting causes are abuse of atropin, abandoned lens remains, incarceration of iris or of the capsule, rudeness in delivering lens or in the capsulotomy, or anything that tends to the excitation of uveitis. Delayed union of the wound has been set down as a factor for the reasons alluded to under that head.

However, one should not always look to the eye alone for the cause of the glaucoma. There are times when the disease is undoubtedly due to a more remote systemic condition. This may be some kind of autointoxication, as from renal insufficiency; or it may be a form of discrasy, like gout or syphilis. According to De Lapersonne, uric acid retention tends to excite glaucoma by the production of a species of edema of the vitreous. These facts serve to emphasize the importance of a thorough physical examination in connection with the operation of extraction. In this way one may at times be greatly aided in the choice of a remedy with which to combat a complication—be enabled, for example, to cut short an attack of glaucoma by measures other than surgical.

The combined operation, because of the frequent involvement of some part of the iris in the healing of the incision, is thought to favor glaucoma more than is the simple. When the tension is obviously due to swelling cortex behind the iris after simple extraction, iridectomy should be immediately resorted to and whatever is feasible of the offending material removed. In the great majority of instances, however, the cortex will have become encapsuled or so adherent that its attempted riddance is out of the question. In

some of the milder forms the process can be stopped by the use of pilocarpin or eserin, but prompt iridectomy or anterior sclerotomy (*paracentesis*) will be required in all the others.

Postoperative lunacy, senile dementia, delirium loquace, etc., are various names that refer to a mental disorder that is not uncommon after the extraction of senile cataract. The degree varies from slight confusion of thought and incoherence of speech to violent maniacal frenzy. The predominant idea throughout is that of having been deserted, left in darkness or among strangers when in dire distress—a state akin to what is known as nostalgia. The sufferer wants to go home and continually calls for those nearest or dearest. He wants to flee from his persecutors, and herein lies the greatest danger. It is not to the lame eye—indeed, it is astonishing how seldom aught injurious ever comes to it—but it is the life and limb of the patient. Thought or conceit of that organ does not enter into his plight. He wants to get away and, in the severe cases, he *goes*, and if not restrained, in seeking an exit, he tries to scale the walls, to climb the door, to throw himself out of the window, or over the railing of the stairs. So that the list of fatal casualities from this cause is nothing short of appalling.

The subject was fully discussed at the 1903 meeting of the American Ophthalmologic Society, as the result of an admirable paper then read by Kipp, of Newark, N. J., and published in Knapp's Archives, July 19, 1903. In the January, 1904, number of Knapp's Archives, C. E. Finlay, of Havana, Cuba, calls attention to a paper by C. Fromaget, of Bordeaux in the *Annales d'occulistique*, cxxiii, p. 183, in which "he considers the delirium following eye operations the result of an autointoxication, most often uremic, and due to the accumulation in the system of certain excrementitious products brought about by some renal insufficiency, and which is made patent by a diminution in the amount of urine, in its specific gravity or in the proportion of urea." Dr. Finlay cites a case of his own in support of Fromaget's theory.

Whatever else may contribute to this ailment—the toxic effect of mydriatics or what not—it is certain that confinement in a strange place and darkness are very largely responsible; the bandaging of both eyes, total darkness in the room, etc. For the same reasons, there are many individuals, both old and young, who are unable to

sleep where, on awaking in the night, they cannot see a light. Be the latter ever so faint, it answers the purpose.

Kipp advocates that, where the distance is not inconvenient, the patient be taken home in order that he may recover his faculties. The next best thing is to have a member of his fami'y come to him and coax him back to reason; or, if this cannot be done, the soothing must be left to those in attendance. Bromids and chloral are sometimes of avail, though it is often impossible to induce the patient to swallow anything. The well eye, if there be one, and it is occluded, should be uncovered at the first signs of the disturbance, and the patient must be watched and guarded *without an instant's intermission.* Knapp, in De Schweinitz's, "Diseases of the Eye," commends hypodermic injections of hyoscin (hydrobromate), gr. 1/100 *pro dosi,* to control the mania.

Atropin Dermatitis.—The well-known idiosyncrasy whereby the local use of atropin or kindred drugs causes a peculiar, nasty, greasy swelling and inflammation of the skin of the lids, must be watched for and, if shown, another mydriatic, such as duboisin or hyoscin, substituted. Usually this suffices, though rarely each one has the same effect and must all be abandoned.

Hyphema, or hemorrhage in the anterior chamber, which is an occasional occurrence, is more often noted after the combined, than after the simple extraction, and was especially frequent after the Graefe modified linear. The predisposing cause is hyperemia of the iris, and the exciting one either a blow or a strain, or it means a threatened iritis. In the latter event, it is an indication for atropin, salicylates, etc.

Spastic or senile entropion of the lower lid, induced by bandaging, is a condition much to be apprehended after extraction. Eyes have been lost through want of timely observance of it. If the lower lid shows the slightest tendency to roll in, measures, such as strapping it down to the cheek with collodionized gauze or strips of rubber adhesive plaster or the putting in of an Arlt suture, must be taken at once.

Kianopia, kianopsia, blavinopsia, or blue vision, is a very common accompaniment of the early attempts of an eye to see after the extraction from it of a senile cataract—nuclear cataract in particular. Becker thought that it is due to the diffusion of light

by thin layers of cortex and that the disappearance of it was the result of the absorption of the latter.

The more commonly accepted explanation of the phenomenon is that the light, entering the eye, has for a long time been filtered through a yellow medium—the amber-colored lens; and when, upon removal of this, white light is again admitted, it is the complement of the yellow, or the strongly contrasting blue, that prevails until the eye becomes accustomed to the change. The phenomenon soon disappears.

Erythropsia, or red vision, is declared by some observers to be more common after extraction of senile cataract than blue vision. Such has not been my experience. Fuchs accounts for it in this connection, as follows: the aphakic eye is more disposed to it because the lens has fluorescent properties and, moreover, in old people, is yellow. It, therefore, while present, prevents the entrance into the eye of great numbers of the rays of short vibrations at the violet end of the spectrum, and its absence, allowing the free entrance of these, *soon causes, in these eyes long unused to such light,* exhaustion of the retina, like snow-blindness.

SIMPLE PERIPHERAL CORNEAL FLAP EXTRACTION COMBINED WITH IRIDECTOMY.

In discussions of the relative merits of the simple and the combined operations for the extraction of cataract, the decision of the argument is supposed to rest upon one's answer to the question, "If your own eye were to be operated upon, which method would you choose?" My reply would be, "It would depend upon the kind or stage of the cataract and upon what surgeon was called to make the operation."

The ultimate success of the operation of extraction does not depend so much upon the particular mode that is adopted of the several in vogue, as might at a glance be supposed. It is a question, *largely* of personal equation. Ophthalmic surgeons characterized by the greatest aptitude in this most exacting of operations, as, for example, Knapp, with a record of four thousand extractions, most all prefer the simple method. They may have had their periods of disaffection in regard to it, but they have ended by coming back to it

in nearly every instance. Indeed, I doubt not, were the originators of iridectomy, in connection with extraction, alive to-day in this era of antiseptic surgery, they would be among the strongest advocates of the simple extraction. For it must be remembered that v. Graefe, with the small iridectomy he made in conjunction with his postcorneal linear section, and Jacobson, who a year or two later operated downward with a very broad iridectomy, both sought by means of the coloboma not to avoid iris complications or to favor the removal of lens remains, *but to lessen the chances of suppuration and panophthalmitis.*

In skillful hands the simple operation is the safer and better in every way. If, on the other hand, the operator is wanting in experience or is not sure of his technic, then, perhaps, in the interests of all concerned, his choice should be for the combined or, better still, for extraction after a preliminary iridectomy. The writer's observation and experience confirm him in the belief that, all things else being equal, there are fewer accidents both during and after the operation of simple extraction, and that when these do occur, they can be better dealt with. Nevertheless, iridectomy in relation to operations for cataract has, and will ever retain, an important place, whether it precedes the extraction by a certain period or is coincident with it.

Indications for the Combined Operation.—Among the cataracts that require it may be mentioned those whose capsules are adherent to the iris, unripe cataracts, or those having a quantity of soft, transparent cortex, diabetic cataracts, and those attended by a rigid pupil, or one irresponsive to mydriatics; as also the luxated and tremulous cataracts. These indications, it may be added, are not always apparent when the exigencies of the operation are being discussed. Hence, in preparing the instruments for any cataract operation where iridectomy has not already been performed, the iris scissors and forceps must never be omitted.

As to the kind of iridectomy, there are a number of opinions and practices. A few years back, the majority of operators made what is called the "keyhole" coloboma, requiring for its proper fashioning, three snips of the scissors. The first, straight from the pupillary border to the periphery of the iris; the second, along the periphery to form the base of the coloboma, and the third, from

the latter, straight back to the pupil again. This form is now more specifically identified with iridectomy for glaucoma, for which it is the most effective. Recently the prevailing choice, excepting, of course, in those cases complicated by glaucoma, is for the one-snip section, such as has been for a long time the kind made for optic coloboma. It obviates as effectually the difficulties of the extraction and more effectually some of the dangers. It is simpler and quicker in the performance, less painful, causes less deformity, and its coloboma, being free from the long, flabby pillars, with their sharp corners that characterize the keyhole pupil, the risks of prolapse and incarceration of the iris are not so great.

The size of the piece of iris excised need not, as a rule, be large. All that is requistite, usually, is the resection of a small bit of the sphincter alone, but its exact dimensions must be left to the judgment of the operator. As to the manner of procedure, it does not differ materially from that of the same operation made for other purposes (see chapter on Optic Iridectomy). When one expects before making the corneal incision to cut the iris also, leaving of a conjunctival flap is not so imperative, though it is desirable in any event.

The idea of making the iridectomy some weeks previous to the extraction, occurred first to Mooren, of Berlin, in 1862. He applied it to *all* the cases of cataract that seemed to demand iridectomy, whereas we of to-day limit it to those only where the combined operation seems inexpedient, such as the beginning of progressive cataract in feeble subjects and in eyes characterized by posterior synechia and glaucoma. It is also applicable to most of those enumerated as suitable for the combined operation. The same methods are pursued, excepting, of course, that the incision is made with the lance instead of the Graefe knife. The shape and extent of the coloboma are regulated as in the combined extraction. Be it understood, however, that in a case of glaucoma associated with cataract, a long postscleral section and a broad peripheral *preliminary* iridectomy are *de rigueur.*

The writer has had no experience with buttonholing the iris, as practised by a few opthalmic surgeons and which is treated of in the chapter on Accidents Consecutive to Extraction. This consists in picking up a small fold midway of the iris zone and cutting out

a tiny ellipse. The idea is that this hole shall form a sluice gate, as it were, for the aqueous in case of after-opening of the incision, thereby preventing prolapse or impalement of the iris.

Variations of Technic.—The different steps of the operation for cataract extraction with the corneal flap, as described in a previous chapter, are by no means constant, but are subject to many modifications and changes, according either to the peculiarities of the case, or to the views of individual operators. It is the purpose of this section, therefore, to cite some of the changes in, or departures from, prevalent methods, or, rather, from the methods already described.

FIG. 241.

Holding the Lids Apart.—Some surgeons prefer to operate for cataract without the blepharostat, instead, having an assistant perform this service with his fingers or with the Desmarres retractors. The fingers alone are unreliable, especially in the event of a squeezing subject. The retractors, or at least one retractor for the upper lid, is a safe and effective means of holding the lids. A new and highly efficient retractor is that devised by Fisher, of Chicago. Shown in Fig. 241. Its handle is of spring steel, and lies over the frontal bone. Thus both the handle of the instrument and the hand that holds it are out of the way of the operator.

Fixation of the Globe.—One may employ a fixation forceps provided with a locking device, but this does not conform to the later and more approved ideas. Many unpleasant accidents have occurred as a result of the lock, for it is apt to prove stubborn in an emergency, and is, on the whole, best dispensed with. An excellent method of fixation, and one peculiarly adapted to use in connection with deeply set eyes, is that of Czermak. This consists in grasping the tissue at the middle of the inferonasal quadrant of the corneal limbus, in lieu of that

situated immediately below. By this mode the leverage exerted upon the globe by the knife, in beginning the incision, is overcome. Besides, the handling of the forceps is not interfered with by contact with the lower lid-holder of the blepharostat.

Angelucci's Fixation.—Angelucci, of Palermo, has given us a procedure that was truly an inspiration on the part of its eminent originator. This is to rotate the globe far downward and to seize, with strong fixation forceps, the tendon of the superior rectus. In this way not only is the eye perfectly steadied, but the upper lid is held out of the way. Moreover, squeezing and attempts to roll the globe upward, on the part of the patient, are done away with, there is no tendency toward gaping of the wound, and the eye can be closed on the instant when this is needful. This method is further treated of under modified forms of extraction. The other recti tendons may be similarly utilized.

Making the incision or corneal section. This lies either exactly in the apparent sclero-corneal junction throughout (with or without the conjunctival flap) or in this position for the lower two-thirds of its course and is turned forward for the last third, ending a line or two short of the upper limbus. Or the same form and direction may be adhered to, while the *position* is just forward of the junction. The extent of the incision varies somewhat with every operator—at one time through mere accident and at another because of a definite object to be attained, as, for example, when the lens is thought to be large and firm, or *vice versa.* Rarely does it include as much as half the corneal base (one-half the diameter), and more rarely still, as little as one-third (one-fourth the diameter), the average being about two-fifths of the *diameter*, or about 7/16 of the circumference.

Conjunctival Bridge.—The conjunctival flap has in some instances been left undivided posteriorly. Pensier, of Avignon,[1] and Vacher,[2] of Orleans, hoping thereby to more surely prevent vitreous loss prolapse and inclusion of the iris from simple extraction, conceived the idea of leaving a broad strip of conjunctiva uncut at the summit of the incision, then delivering the lens and removing the

[1] "L'extraction sous conjunctivale de la cataract," Ann. d'oc., 1899, T. cxxii, p. 267 et 1900.

[2] "Operation de la cataracte par le procédé a pont scleroconjonctival," xiii. Congr. intern. des sc. méd., sect. d'opht., Paris, 1900.

cortex from beneath this bridge. They made upward section. Desmarres is said to have operated similarly, with downward section, nearly sixty years ago. Others left the bridge only until the blepharostat was removed, in order to prevent vitreous escape, and then divided it before proceeding with the extraction.

Subconjunctival Extraction.—Czermak went further and evolved his "conjunctival pouch" operation (Fig. 242). Czermak's object was to render the eye safer from both primary and secondary prolapse and infection, especially to protect the wound during the period of healing, from outward contamination, and to avert prolapse of the iris. The section was made downward when iridectomy was to be omitted, and upward when not. The incision was begun with a 3 mm. broad Graefe knife by puncturing the anterior chamber *via* a long conjunctival route, withdrawing the knife, then extending the conjunctival cut downward and outward (or upward and outward, as the case might be), and undermining the conjunctiva about the site of the proposed incision. The latter was completed by means of scissors. The lens was delivered, and the cortex worked out in the usual manner, the spoon or the spatula being manipulated beneath the conjunctiva in the pouch. The few advantages sought were more than offset by the added difficulties and complications incident to this mode of procedure; though in a few selected cases the operation with downward section is of positive value, for instance, in very deeply sunken eyes and those whose conjunctival sacs are much atrophied, as from old trachoma. It has been often observed that gaping of the incision occurred when made beneath the conjunctiva or even with too large a flap of this membrane.

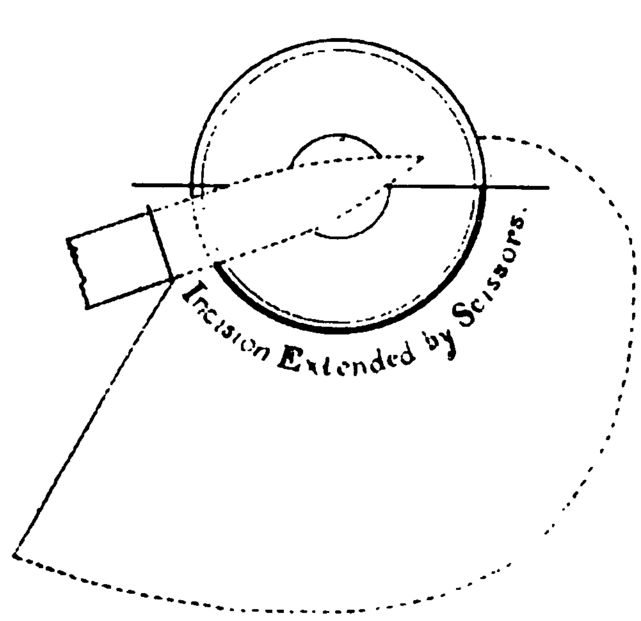


FIG. 242.

Suturing of Corneal Wound.—First done, after extraction, by Williams, of Boston, in 1867, and since tried by many operators, notable among whom are Mendoza, Kalt, Czermak, L. Müller, Bourgeois, and Schweigger. The thread has been inserted in several ways, usually engaging the cornea, on the one hand, and the conjunctiva and episcleral tissue on the other, but never passing entirely

through the cornea. Some, like Czermak, put the thread in after completing the section; others after only partially making the cut, and yet others, before beginning it. Bourgeois,[1] of Reims, in addition to the corneal suture, made a special form of outward section. The corneal suture has not proven a preventive of prolapse or incarceration of the iris, as it was hoped; nor does it hasten cicatrization. Besides, it is difficult to place, it prolongs the operation, it harasses the patient, and the knot in the thread is a source of irritation.

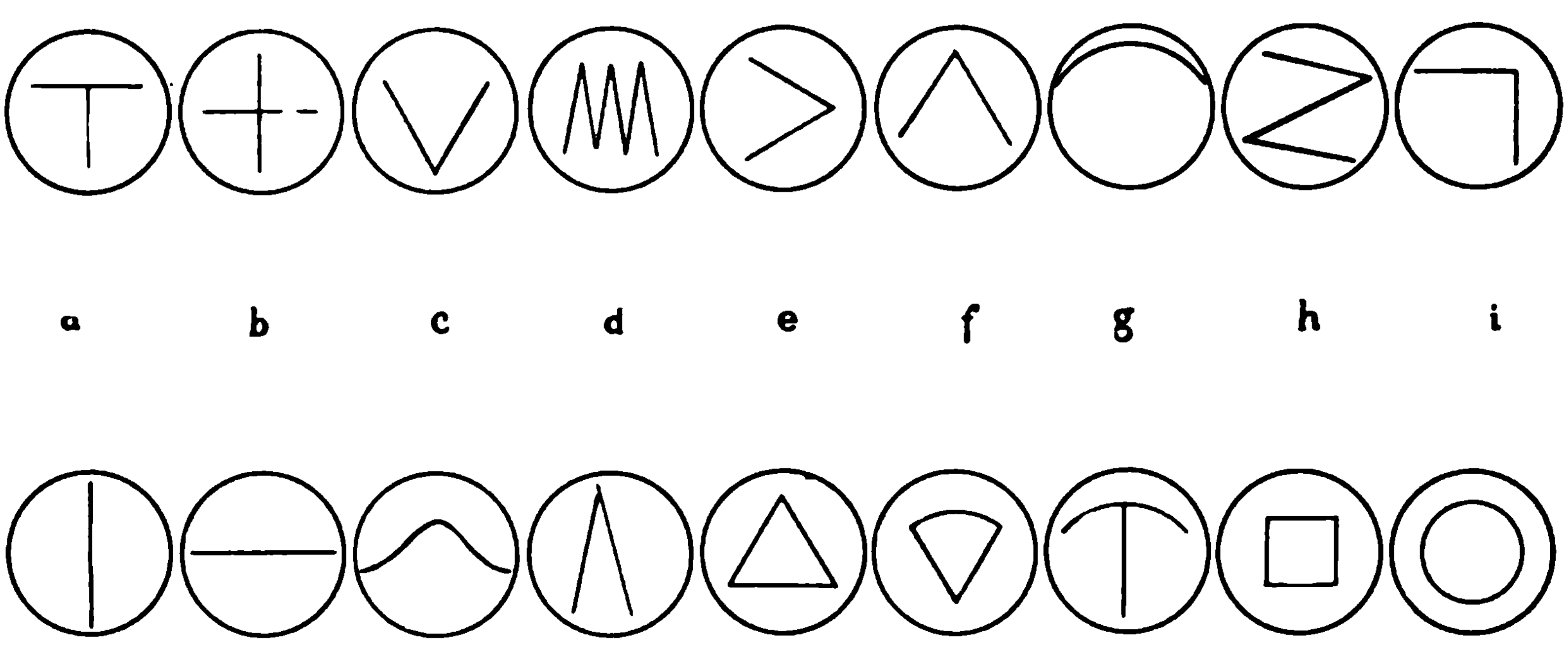


FIG. 243.—Forms of capsulotomy. The circle represents the dilated pupil. Those incisions that make angles whose bases are toward the corneal incision are bad because their flaps and tags get into the wound to cause iris prolapse and to delay healing. a, Von Graefe. b, Von Graefe, (crucial). c, Von Arlt. d, Von Arlt. c, Weber. f, DeWecker. g, Knapp. h, Czermak. i, Agnew.

Suturing of the conjunctival flap has also been tried and with equally unsatisfactory results.

Opening the Capsule.—From Daviel's time down to the present, the prevailing method of opening the capsule has been to cut or scratch it by means of a pointed instrument—either a straight or an angular needle with one or both edges cutting, or a combination of knife and needle. The position and extent of the cut have been much varied (see Fig. 243). That is to say, *theoretically* they have been of such and such forms, but, in reality, the figure assumed by the rent in the anterior capsule has, doubtless, been a very nondescript sort of affair. Knapp has said of it, "mostly, it (the capsulotomy) consists in an extensive and promiscuous laceration." The particular style or direction of the capsulotomy is generally supposed to have some bearing upon the healing process and, also,

[1] Annales d'oculist, Jan., 1901, p. 10.

upon the frequency of secondary cataract. Unquestionably, that manner of capsulotomy which gives the greatest number of stray fragments or shreds would be the kind most often to exert an evil influence upon the wound healing, but over its power to affect the density of the membranous remains or secondary cataract one has but little control. The author believes, with Panas, that it is not so much the method pursued in the cystotomy, as the amount of abandoned lens remains that predisposes, or not, to the formation of secondary cataract.

A number of operators, first and last, have followed the example of the Barons de Wenzel (father and son), who in the latter part of the 18th century (about 1786), began the practice of making the capsulotomy with the point of the corneal knife or keratome—*chemin faisant*, as they expressed it; i.e., after making the puncture, the point of the knife is advanced to the pupil, depressed till in contact with the capsule, a certain movement is made to incise the capsule, and, following this, the counterpuncture is made, and the section completed in the ordinary way. Among those who have of late years revived this old method have been Gayet, of Lyons, and Galezowski and Trousseau, of Paris. The last operator goes so far as to employ no other instrument in the entire operation of simple extraction save the Graefe knife.

The guiding principle in the making of the capsulotomy and corneal section simultaneously is the lessening of the hazards of the operation by the insertion of the fewest instruments possible. Now however commendable this may be and clever as is the feat, it is not good surgery. Each of the operative steps is of too great importance to be accomplished by a bungling compromise which is disparaging to both. For, as to the capsulotomy, it is apt to be insufficient and wrongly placed If there is an opaque liquid (Morgagnian) within the capsule, this escapes, thus obscuring the field and embarrassing the operator; and if the capsule is resisting, there is greater risk of rupturing the zonule. It also inclines to jaggedness of the corneal incision and premature escape of the aqueous, all of which but tends to vitiate the result.

Daviel practised plucking out, or *arrachement*, of the anterior capsule when it was th ckened, etc. De Wecker, of Paris, thought to advance the status of cataract extraction, especially in regard to

immunity from after-cataract, by tearing away all or a portion of the anterior capsule as a systematic measure, and withdrawing it from the eye. For this he had constructed a pair of specially designed forceps, with sharp back teeth, which he named, "forceps-cystotome." These he used with more or less regularity for a time, and could boast of having his example followed by such men as Schweigger, Knapp, and Fuchs, but the procedure has mostly fallen into merited disuse, saving for a few chosen cases such as lenses with opaque capsules, for the removal of which the procedure and the forceps still serve admirably. Its shortcomings are in many respects similar to those of combining the cystotomy with the corneal section, viz., uncertainty as to the extent and character of the opening and rupture of the zonule from the pressure that must be made in order to seize the capsular membrane. It is difficult of accomplishment through a small pupil.

I prefer Knapp's peripheral capsulotomy to others because it gives the most rationally situated opening for the exit of the lens; it lends itself to the horizontal manipulation of the cystotome; being close up under the incision, the impulse of the lens as it rises in the direction of least resistance can be readily observed. Where an iridectomy has been made, the coloboma affords an open field for nearly the requisite length of the incision; yet, a small round pupil does not interfere with its proper making, since the extremities can easily be extended beneath the iris. It has not been proven—as has been asserted—that it leads oftener than any other method to the formation of after-cataract.

Expelling the Lens.—For this, instead of using spoons, externally applied to the globe, some surgeons resort to pressure with the fingers, placed either directly upon the eyeball or acting through the medium of the lids. When we reflect how utterly impracticable it is to rid the fingers, the conjunctiva, the cilia, and the orifices along the lid margins of bacteria, the clumsiness of this measure is lost sight of, and we wonder only at its uncleanliness—surgically speaking.

Clearing Out Lens Remains.—Irrigation of the anterior chamber for washing out the cortex has been variously tried, as to the instrument, the technic, and the quality of the liquid employed, and, for the most part, abandoned, it being ineffective for any but

the light, fluffy, and more innocuous kind and, at the same time, too often provocative of unfavorable reaction. Panas has been referred to as the originator of this process, which is an error, as his lavage was purely to free the anterior chamber of possible sepsis. Its real origin goes much farther back—even to Guérin, and the year 1773. It was little practised, however, till revived by Heymann,[1] who used physiologic salt solution for cleansing the eye of blood. Since that few have not, at some time, tried it, in conjunction with extraction, yet few also have become advocates of it as a routine practice. The chief exponent of the measure in this country is Lippincott,[2] of Pittsburg; and the latest model of his irrigator is probably the most suitable instrument for the purpose. Lately a small coterie of ophthalmic surgeons at Bordeaux[3] have insisted that the double-cannula piston syringe, for simultaneous injection and aspiration, is the only fitting instrument. A review of the subject by the present writer is to be found in the *Ophthalmic Record* for March, 1905.

Fuchs, of Vienna, actually puts a spoon, similar to Desmarres', into the anterior chamber and ladles out the remaining cortex. This seems a bold proceeding, though it works to the entire satisfaction of its distinguished partisan, which counts in its favor.

COMPLICATED AND SOFT CATARACTS AND SPECIAL MODES OF EXTRACTION.

Under this heading may be classed all those cataracts that do not, generally speaking, admit of being handled according to the methods already described or by the treatment to which other methods are better adapted. Among these may be mentioned shrunken, adherent, dense membranous, tremulous, dislocated and soft, swollen cataracts causing glaucoma after discission. A brief discussion of them in the order of their importance follows.

Linear Extraction.—This term refers to the manner of making the incision (full linear incision has already been spoken of). To-day, when one uses the term, it means merely an incision with the lance-knife or keratome, and is the kind best fitted for several va-

[1] Klin. Mbl. f. Aug., 1864, S. 305.
[2] Am. Jour. of Oph'y., July, 1904.
[3] Archives d'ophtalmologie, Feb., 1905.

rieties, of cataract—notably, shrunken cataracts, those membranous cataracts that are too dense or too tough for ordinary discission, zonular cataracts, and for the extraction of those swollen lens masses that, after discission, cause serious reaction, such as high tension, etc. In truth, it is my belief that the keratome could, in many instances, be used with advantage to supersede the Graefe knife.

Advantages of the Keratome.—Its wound heals with exceptional readiness and kindliness. This is probably owing to the fact that it lies chiefly in one plane, without notching and other unevenness. The aqueous humor can be better controlled, i.e., it can be more surely held back or evacuated with greater discernment; hence, also, the iris behaves better; the act of making the cut is less startling to the patient and he remains more quiet, thus reducing the risks. So, for these and other reasons, the incision can be more accurately placed. The most commonly urged objection to the keratome for cataract extraction is that the wound opening is too small. If one will practise on pigs' eyes, the making of a surprisingly large opening, of very short wound canal, is speedily arrived at. The essentials are that the blade be extra broad, that in starting the cut the lane of the blade be held about at a right angle to the corneal curve until the point enters the anterior chamber, then depressed till it is parallel with the plane of the iris, holding strictly to this and advancing until the point cannot be pushed any further. Then the heel of the knife is turned to the side where the cutting lacks most, holding if possible to the same plane, and the incision is extended while withdrawing the blade. It is my custom, when a long cut is needed, to begin not in the vertical meridian, but a little to the left of it, and finish by lengthening it to the right. The eye must be carefully steadied during this final maneuver, the knife held very firmly, and the sweep that makes the extension be executed not too swiftly, else the patient may wince, or the direction of that part of the incision be faulty or dangerous. In this way, the anterior chamber being of normal or greater than normal depth, a wound opening measuring a centimeter or more—quite ample for the exit of an average sized lens—can, after a little preliminary practice, as suggested, be quite readily accompl shed. It is most suitable for purposes of extraction when it lies, throughout, barely anterior to the apparent sclero-corneal junction.

If, after all, the incision seems inadequate, it can be enlarged with scissors or blunt-curved knife. That these, or one of them, are at hand, ready prepared and *extra sharp*, goes without saying. If a conjunctival flap is desired, it may be first fashioned with forceps and scissors, then turned down, over the cornea, and the keratome incision proceeded with.

Shrunken, adherent, and dense capsular are several qualities often found in a single cataract. They are most frequently met with in old traumatic cataracts, particularly those that have been at some time attended with, partial absorption or inflammatory processes, and are characterized by calcific and connective-tissue degeneration. Not unlike these, in many respects, are the shriveled and generally anomalous varieties of congenital cataract. These and the dislocated cataracts, in short, all that are not best dealt with by the flap operations, previously described, or by discission, are proper subjects for extraction with keratome incision. In but few is the use of the cystotome indicated. In that form where there is considerable posterior synechia with dense anterior capsular opacity—which makes the plucking out of the latter with the back-tooth forceps impracticable—it is best to make preliminary iridectomy. This will expose a greater area, wherein, when it comes to the extraction, a fair and sufficient capsulotomy can be made and the lens expelled in the regular manner. A subsequent discission of the thick membranous cataract which is left behind is usually sufficient to establish a good pupil. In the event of dense anterior capsular cataract *without* a great deal of posterior synechia, withdrawal with the capsule forceps is a good procedure. It may happen that the lens will come out with it—so much the better; but it is well to watch closely and be prepared for this contingency

Whenever preferable, from inability to dilate the pupil or any cause, to make iridectomy in these peculiar cases, the preliminary is the best. There will then be no blood in the anterior chamber to hamper the extraction, the degree of traumatism will be less and, moreover, one learns something of the character of the patient before reaching the more critical operation of extraction. An upward iridectomy and extraction are preferable, though the position of the least number of iris adhesions or of a dislocated lens will sometimes furnish reasons for departing from the rule. In all save

those in which a regulation capsulotomy is feasible, a traction instrument for the getting out of the cataract will be necessary. My preference is for the open sharp hook for the lenses and the blunt hook or iris forceps for the mats. Each operator must decide as to whether local or general anesthesia be employed in a given case. I have made a great number of extractions of complicated cataracts, many of which were luxated, and I have not resorted to general anesthesia as many as three times.

For the better elucidation of this subject, permit the citing of actual cases illustrative of the several kinds of cataracts and of the methods alluded to in this chapter, wherein they were put by the author to a practical and successful test.

Case 1. **Example of Extraction of a Shrunken, Lightly Adherent Cataract, with Calcific Degeneration of the Anterior Capsule.**—Stewart S., age 22, farmer. Came to me September 15, 1903. At age of 7 years received blow in the right eye from end of stick in the hand of a small brother. In due time the sight of the eye failed and the pupil looked white. The central portion of the cataract was snow-white and dense. The iris was adherent below, while the rest of the pupil dilated fairly well. The denser portion of the cataract was about the size of the normal pupil, the rest was gray with radiating streaks of white, and the whole looked shrunken.

The operation occurred September 17, 1903, at the Passavant Hospital. Cocain. Incision with broad keratome was made at the upper sclero-corneal junction and the point of the knife made to incise the zonule below. While the upper lid was held back by an assistant, De Wecker's capsulotomy forceps, or forceps cystotome, was introduced, the thick portion of the capsule was seized and withdrawn. This set free the small, hard, opaque lens, about the size and shape of a lentil. Behind this the small sharp hook, of well open pattern, was inserted flatwise, then turned point forward and the lens caught and delivered. After closing the eye and waiting a few moments, the iris, although it had been pulled slightly into the wound, was found again in place with round pupil. There was no loss of vitreous. The eye recovered promptly, but with little vision, owing to rupture of the choroid caused by the original injury. The patient returned to his home in Iowa on the 26th of the same month.

For cases of complete posterior synechia with cataract, where an attempt at iridectomy would but result in stripping off the outer layers, leaving the uvea on the capsule, and where the anterior chamber is extremely shallow, the operation of de Wenzel might be resorted to. The elder de Wenzel, about a century and a quarter ago, devised an operation for that forlorn class of cases characterized by very extensive or total posterior synechia with thickened anterior capsule or atresia of the pupil, shallow anterior chamber, etc., that is not a bad procedure to-day. It was the making of a large corneal flap just as for the ordinary extraction, except that it included the iris and lens. In other words, the knife was made to pass through these tissues as if they did not exist. Then as much as was practicable of the iris flap was excised, and the lens expelled by external pressure. Snellen, "Operationslehre," of the Graefe-Saemisch Handbook, p. 46, cites the case of an eye upon which he himself made the de Wenzel operation with brilliant success.

Case 2. **Example of Extractions of Congenital Capsulo-lenticular Cataract. Agnew's Modified Hook Operation.**— This is the method by which, while serving as house surgeon, I had seen Dr. Agnew, of New York, make extraction in similar cases, at the Manhattan Eye and Ear Hospital. I know that his first hook extractions were made as follows:

He first introduced a strong needle through the cornea, infero-temporally (for the right eye), passed it through the lower junction of cataract and zonule, gave it a rocking motion to enlarge the opening slightly, held the needle there to fix the eye, made keratome incision above, and put in a blunt hook. He then withdrew the needle and inserted the hook at the opening made in the cataract by the needle, pulled out the cataract and had an assistant cut its zonule off as one would the iris in iridectomy. He had abandoned this method before my connection with the hospital and before I became familiar with his work.

Archie K., age 16 months, German. Brought by his parents May 3, 1888. Born with "white pupils." There were also convergent strabismus and nystagmus. The pupils dilated freely under mydriatic. Cataracts were exactly alike in both eyes. The central portions, occupying an area above the size of the normal pupil, were

dense, thick, and chalky-white, of irregularly rounded outline. Radiating from these were numerous streaks of white and gray, in places so thin as to be almost transparent, the whole having a wrinkled appearance and apparently containing no soft material. Evidently, not a case for either discission or dilaceration. Advised extraction.

June 15, 1888. **Agnew's blunt-hook operation,** the technic of which is as follows: Right eye. Pupil dilated. Chloroform. Superior keratotomy with lance-knife or iridectomy knife, point pushed far in and thrust through the cataract, or rather through the zonule, below the thicker portion, and behind the lower border of the pupil. While an assistant steadied the eye with the fixation forceps, I took the blunt hook in the left hand and iris scissors in the right, introduced the former at the wound, inserted the point in the cut made through the cataract below, made slow traction, at the same time giving the handle of the hook about a quarter turn on its long axis, so as to pass the crook flatwise through the incision, drew out all the thicker portion of the cataract and cut off the adherent zonular shreds close to the cornea. No loss of vitreous, no iris complications. Quick recovery with round black pupil.

August 2, 1888. The same operation was made on the left eye. Same result, except that a single adhesion occurred below, where the iris was so drawn upward as to produce a heart-shaped pupil. This was later freed by discission and the pupil became round. The boy was last seen in August, 1897, when I made advancement of the left externus for the correction of the squint. At this time, when sent back to his home in Ohio, there was no strabismus, the nystagmus was hardly perceptible, and the vision of each eye, with lens of +10 D, was 20/70. The reduced vision being due to lack of development of the retinæ and choroidea, common to these cases.

I have since, in numerous instances, availed myself of the great advantages afforded by this procedure, and always with most gratifying results. It is specially applicable to certain forms of congenital cataract, such as the irregular zonular type, that are of stunted growth, and are more or less apaque throughout; also to the dry largely membranous ones, named by Schmidt "*aride siliqueuse*" cataracts. The measure is equally suitable for the extraction of many of the shrunken traumatic cataracts. A trained assistant is

needed, particularly if narcosis is employed, to fix the globe, after the incision is made, leaving the operator free to use both hands in manipulating hook and scissors.

Case 4. **Example of Extraction of Large, Slightly Luxated, Tremulous Morgagnian Cataract. Angelucci's Fixation.**— Robert Cummings, age 64, shoemaker. Admitted to the Illinois Charitable Eye and Ear Infirmary, October 1, 1903. Left eye became inflamed and sight impaired twelve years ago, and has since been subject to frequent attacks of pain and redness with gradual loss of vision. Lost sight of right eye six weeks or two months ago. Condition on admission: right eye slightly red; cataract of an even whiteness; iris molded to the lens, and both very tremulous; pupil responds to mydriatic. The lens is misplaced slightly inward. Anterior chamber rather deep, T normal, fair perception of light, field and projection faulty. Left eye dusky red, globe very soft. Myosis. Iris adherent to anterior capsule of lens, the latter being thick and white. Bare perception of light, with field of vision and projection lacking.

Seeing that capsulotomy is out of the question in the extraction of a dislocated lens, the incision is followed immediately by the delivery of the lens with a traction instrument. The incision is sometimes best made with the Graefe knife, though occasionally with the keratome, and the operator must use his judgment, in view of the size and relation of the lens to its surroundings.

For the extraction made in this case, the writer availed himself of the method of fixing the eye and of holding it open, devised by A. Angelucci.[1]

October 5, 1903. Preliminary iridectomy of right eye. Following the excision of the iris, notwithstanding the fact that the patient's behavior was the very best and nothing was pressing on the eye, a small quantity of thin vitreous flowed from the wound. After this, all went well and the eye was quiet by the 10th of the month. Through the large coloboma, the milk-white cataract could be seen extending very far out, i.e., the equator of the lens was not yet in view. The problem that now presented itself, was how to extract the cataract with promise of smallest loss of vitreous. Resolved to try the method of Angelucci. This is to hold the globe by seizing

[1] Arch. di ott., vol. v, fasc. 3-4.

with strong fixation forceps (no catch) the tendon of the superior rectus muscle. This was put into execution October 29th, and my sincere thanks, as well as those of the patient, are due the noted Italian surgeon for a measure that was truly an inspiration.

The eye was cocainized, the upper lid held back, the patient told to look down, and the whole tendon of the superior rectus was caught, not in a fold, but by placing a jaw of the forceps on either side of it. A free upward section of the cornea was made with a small Graefe knife, the open sharp hook was inserted behind the lens, dug into it, and, at the first pull, the capsule ruptured and there gushed out of the incision a great quantity of *liquor morgagnie.* It did not get in front of the lens, yet after its escape the pupil was black—no cataract was to be seen. The first thought was, of course, that the hard nucleus had dropped into the vitreous chamber. On peering sharply into the coloboma, however, there appeared the merest glint of gray. Still keeping a firm hold on the tendon, the hook was carefully passed flatwise behind this faint opacity, point turned forward and drawn out. With it came a very large nucleus of inky blackness. Strange to relate, not a drop of vitreous was lost, for not only did the grip on the superior rectus steady the globe perfectly, but it served three other most important functions, viz., it held back the upper lid, it so paralyzed the muscle that there was not the least tendency of the eye to roll upward, and, most essential of all, it *caused strong tendency to closure of the wound.* Fixation by the ordinary method, below the cornea, would have had the opposite effect, and there would certainly have been an outflow of vitreous. The eye recovered without accident and the patient was discharged Nov. 23d, with corrected vision of 20/70. Under treatment the left eye became quiet. I have a number of times since, in cases where there was likely to be loss of vitreous in an extraction, resorted to the Angelucci fixation, and always with the greatest satisfaction.

Case 5. **Example of Extraction of Cataract Dislocated and Lying in the Anterior Chamber.**—William Pearson, age 34, coachman. Admitted to the Eye and Ear Infirmary, October 15, 1892. Recurrent severe inflammation and loss of sight of the right eye. Eye has been operated upon elsewhere (iridectomy) and had since remained quiet, though with a cataract. The day before coming to the hospital, while bridling a horse, the animal in shaking its

head, struck the patient a severe blow on the right temple, when he immediately felt that something had happened to the bad eye. Condition on admission: Right eye painful, conjunctiva injected, large cataractous lens in anterior chamber, upward coloboma of the iris. Vision *nil*. Left eye normal. Operation at once.

Eserin was used, but owing to the previous iridectomy, it had scarcely any effect upon the pupil. While the eye was being put under cocain, I remarked to those around that it would be necessary to introduce a needle to hold up the lens, else it might drop through the large opening into the vitreous. The words were scarcely uttered before, through a quick movement of the eye, the cataract disappeared in the manner suggested. I then turned the man over on his stomach with his face projecting beyond the end of the table and asked him to let me manipulate his head as if it were not attached to his body. By this means the cataract was brought again into the anterior chamber. He was turned on his right side, a delicate Bowman needle was inserted, from the nasal limbus, behind the lens, he was turned further so as to lie somewhat on his back, a downward section of the cornea made and the cataract extracted without other accidents. Recovery was prompt and the eye appearing normal afterward, save for the old coloboma.

Case 6. **Example of Extraction of Swollen Lens Causing Severe Secondary Glaucoma After Discission for High Myopia.**—The citation of this case serves more, perhaps, to point a moral than to adorn a chapter on the surgery of the eye. Sophia Lee, 12 years old, Chinese girl, came under treatment May 5, 1900, wearing −10 D over both eyes. Could no longer see well at a distance with her glasses. Tests then showed R. V. = 2/200; 20/50 w − 16. L. V. = 2/200; 20/70 w − 16. Cylinders did not improve. Ophthalmoscope showed small conus and very striking *fundus tigrée* in both eyes. Advised discissions.

September 11, 1900, tentative discission in left eye, very slight reaction; September 20, 1900, more thorough discission in left eye. Crystalline very soon broke up and by February 1, 1901, had all disappeared, leaving a small capsular band across the pupil. Test showed, L. V. = 10/200; 20/30 + w − 2.5 c ax 155°. April 1, 1901, first slight discission in right eye. No special reaction. April 23, 1901, more decided operation—capsule and lens well incised.

Lens slowly broke up. About May 6th there was considerable swelling of lens and some pain. Eserin was instilled which seemed to relieve the symptoms, and the child was given a solution of the same to use at home. Saturday, May 8, T normal and eye fairly quiet.

Although under instructions to report often, and though she had been very faithful in her attendance at my office, I did not see her again until Wednesday, May 12, 1901. The eye had been very painful since Saturday evening (the 8th), the T was very high and the eye very red. Her mother had objected to her going out, on account of the condition of the eye. I at once made superior keratotomy with keratome. A quantity of soft lens material followed the withdrawal of the instrument. A thin spatula was inserted to hold back the iris and to form a chute for the remaining masses, and by manipulation of a hard-rubber Graefe spoon on the anterior surface of the cornea, most of them came out. The iris was not disturbed. The eye immediately became comfortable, was bandaged, and, with twenty-four-hour dressings, after a few days, seemed to have recovered. On examination of the field, however, it was found lacking on the nasal side. In spite of treatment the defect persisted and to-day it extends barely to the left side of the center. R. V. = 20/200 w + 2cx 90°. The vision of the left, with glasses, is now (Jan., 1904) 20/30 + 2, and she reads the finest print. Has been regularly in school for the past two years. I should never again, under such circumstances, allow the patient to stay at home, but should insist by all means upon the hospital.

EXTRACTION OF THE LENS IN ITS CAPSULE.

Beer, in Vienna, at the close of the 18th century, tried plunging the lance-knife, with which he made the corneal incision, into the lens, mobilizing the latter, completing the section, then expelling the lens by pression. Often, however, the cataract came out with the knife. The first recorded extractions of the cataract and capsule *intact* were made by Samuel Sharp, of London, in 1753. The famous Göttingen surgeon, August Gottlob Richter, took it up twenty years later, or about the year 1773. So, for one hundred and fifty years eye surgeons have striven for that ideal—a safe method

of extraction of the lens in its capsule, applicable to senile cataract in general—thus, once for all, doing away with two of the great evils—the residual cortex and the secondary cataract. After giving it a fair trial, meanwhile endeavoring to correct its faults, these illustrious surgeons relinquished it and *fell in with reclination instead.*

After completing the corneal incision, Richter expressed the lens by steady and gentle squeezing of the globe. Beer, at a later date (1790), introduced a needle at the incision, transfixed the cataract, and by moving it about in various directions loosened the zonule, and then extracted by external pressure. They both operated downward, by large linear incision, and without iridectomy. The method found few imitators and soon fell into disrepute, until revived, in 1845, by Christisen. This operator made pressure upon the globe just before finishing the corneal section, to cause the lens to break its zonule and to present at the wound, completed the section, and expressed.

From 1865 to 1889, the brothers Alexandre and Hermann Pagenstecher, of Wiesbaden, went extensively into the work and, by a long series of extractions, attempted to popularize it, while still making the Graefe modified linear incision. Alexandre Pagenstecher added to it a broad iridectomy, then delivered the lens by means of his broad shallow spoon. Later they adopted the large corneal flap extraction, adhering still to the spoon delivery, but only for the more obstinate lenses that did not respond readily to pressure. The surviving brother, Hermann Pagenstecher, has relinquished the measure save for exceptional cases. As a result of the favorable reports of the operation by these very able surgeons, it was taken up by many others—in this country by Knapp and Roosa.

The last-mentioned surgeon, in 1884, after a visit to Wiesbaden, made a number of intracapsular extractions, but soon became discouraged by the very high percentage of vitreous loss. He essayed the breaking of the zonule by pressing down upon the lens with the knife, just after making the counterpuncture, slightly turning the back of that instrument toward the anterior capsule the while.

Still more recently (1895) the late Gradenigo, of Naples, undertook it. After making corneal section, he introduced a small and

specially constructed blunt hook, which he called a zonulotome, tore the zonule below, and expelled the lens. Delgado first mobilized the lens by entering a needle through the cornea, as if for discission, withdrew it, made a large peripheral (scleral) incision upward, iridectomy, and expulsion of cataract. In short, a great variety of ideas for division or rupture of the zonule have been put into practice. Yet any procedure whereby the zonule is torn or cut before efforts are made to express the lens is open to the serious objection that the vitreous is more likely to present itself at the wound in advance of the lens, thus rendering worse than useless further attempts to expel the cataract by external pressure.

"INDIAN" METHOD.

Of more than passing interest for the past 12 or 14 years has been the exploitation of extraction in the capsule, by extraocular manipulation, under the name of the "Indian method"; and in the same connection one is accustomed to see or to hear the name of Major Henry Smith, of Jullundur, Punjab, India. Herbert, in his most excellent work on Cataract Extraction, 1908, p. 252, says: "The work in India was begun by Mulroney, at Amritsar in the Punjab, in 1890. He made a downward section without iridectomy, and expelled the lens by manipulation. In 1893, 1,145 of these operations were performed as Amritsar. Henry Smith, at Jullundur, also in the Punjab, adopted the method, but preferably with an upper section, and laterly with iridectomy. Obtaining better results, he has expanded the work greatly. Now the extractions at Jullundur number about three thousand per annum. According to Arnold Knapp, the operating season at Jullundur comprises only 6 weeks spring and autumn, about 1,000 extractions occurring in the spring and 2,000 in the fall—42 days for 2,000—or nearly 50 every day. In the year from May 31, 1904, to May 31, 1905, Smith extracted 2,616 cataracts in their capsules, and only 151 with capsulotomy. With this extraordinary experience he has clearly and authoritatively established expression as the correct method of delivering the lens in its capsule, and has shown that it is applicable to the large majority of senile cataracts."

The operation, as performed by Major Smith, given in his own

words, is as follows: "An incision is made upward, beginning in the corneo-scleral junction and ending well within the cornea. It includes a little less than half the circumference of the sclero-cornea. I personally prefer the incision finished in the cornea without a

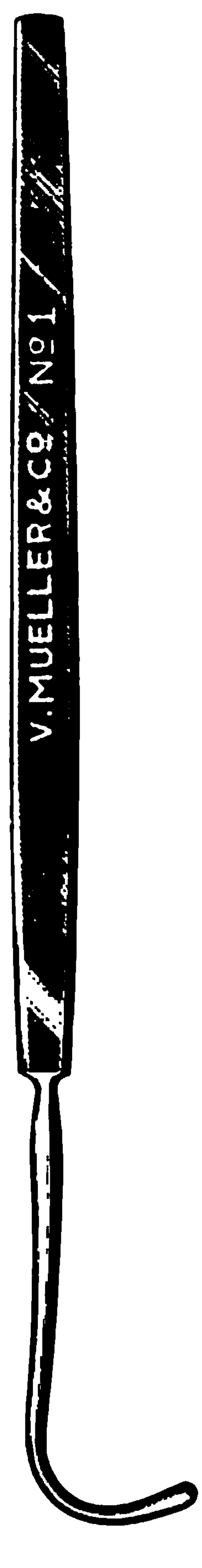


FIG. 244.

FIG. 245.

FIG. 246.

conjunctival flap, as the flap is more or less in the way. An iridectomy may or may not be done, according to the operator's fancy. The speculum is now removed, the assistant draws down the lower eyelid, with the face of his thumb placed on the skin below it; with

his other hand he lifts the upper eyelid forward with a large-sized strabismus hook (Fig. 244), in his first three fingers, as if he were lifting the contents of the orbit out of the socket, and not lifting it toward the brow, using the ring and little finger of the same hand to draw back the brow and orbicularis muscle. This does not imply any violence on the part of the assistant.

"The operator now places the end of a large-sized ophthalmic spatula (Fig. 245), on the left side of the cornea over the junction of the middle and lower third of the lens. He places the end of a large-sized blunt-pointed strabismus hook over the corresponding position to the right of the spatula (Fig. 246). He makes steady pressure backward toward the optic nerve with this spatula, and he makes similar pressure with the strabismus hook except that in making pressure with his strabismus hook he draws it backward and forward across the cornea. The edge of the lens at the wound will be seen to tilt forward and the clear vitreous will be seen between it and the scleral margin of the wound. As soon as this occurs, the pressure with the spatula should practically cease and the same stroking movement of the strabismus hook should be continued, its position not being altered on the cornea at first, but the direction of the pressure exerted through it should be altered gradually more and more in the direction of the wound until it finally folds the cornea beneath the lens; at this stage the lens is delivered. The iris should be replaced if prolapsed. The assistant should then let go the eyelid, and the patient's eye should be dressed up.

"I may here state that my experience now extends to about 20,000 cataract extractions, about 17,000 of which have been in the capsule, and amongst the latter have been many immature cataracts, especially in recent years."

Major Smith lays great stress on two points, viz., that the pressure be gradually applied, and that plenty of time be allowed in delivering the lens. If the first point is not observed the capsule is apt to burst, and neglect of the second is sure to result in loss of vitreous or other complication. "The pressure exerted is moderate, *slow and continuous*, gradually relaxing in amount, as the lens is seen to be well on its outward way. The process must be done slower, and with much more deliberation than in the capsule laceration

operation. The continued pressure quickly tires out the iris, which dilates and allows the lens to emerge very like the process of parturition. If the expression be attempted rapidly, the capsule will probably burst just as it is coming out. If this accident does happen, it is best to keep up the pressure with the hook, so that the capsule does not retract, and try and gently drag it out with a pair of ordinary dissecting forceps applied to the part outside the wound. The broad hold so secured will often succeed in drawing out the whole of it with its contained lens matter."

"When the lens is halfway out . . . a clear point of vitreous will occasionally appear in the wound behind the lens. . . . The spoon in the left hand . . . should be pushed beneath the lens through the clear point and the lens suspended on it. Once the lens is supported on the spoon the strabismus hook can be used as before to drive out the lens, the spoon merely coming with the lens, but not drawing it out. . . . If we attempt to lift out the lens on the spoon merely, the capsule will give away with exceeding frequency."

"In addition to this occasional insertion of the spoon, the iris forceps have sometimes to be introduced to seize ruptured capsule. If the capsule has retracted, we should try by gentle stroking to press out its contained lens matter, . . . and if the capsule be evident to the eye, we may make an attempt to catch it with an iris forceps and fetch it out. Where no accident occurs the only instrument introduced into the globe is the knife. Ordinary dissecting forceps are used for seizing ruptured capsule lying in the wound."

Iritis followed where the capsule was left behind in about 5 per cent. of the cases, and only 0.34% *out of the* 2,616 *were failures:* one due to suppuration; one due to hemorrhage; and in another the eye shrunk after an extensive loss of vitreous. Iritis was, he thought, not due to bruising, but to the retention of lens matter and capsule.

In consequence mainly of Smith's reports many ophthalmic surgeons all over the world have been emboldened to make trial of the method. In the United States alone the number of would-be imitators of Major Smith has been a large one. So far as the writer has been able to inform himself, however, practically all have given up the method, deeming it inadmissible save for an occasional selected case. The chief reasons for their disaffection toward it will be found in the following paragraphs.

The enthusiastic reports of this Anglo-Indian surgeon have led to another attempted revival of this coveted form of extraction, and it will be interesting *to those not immediately concerned* to watch the results.

1. **The High Percentage of Vitreous Loss.**—This is the greatest objection to extraction of the encapsuled lens, and the one that will probably forever prevent its adoption as a routine measure. Moreover, it is to this great drawback that most of the others here enumerated owe their origin. The dire consequences directly and indirectly traceable to this accident have already been treated of under accidents immediate and consecutive. They include expulsive choroidal hemorrhage, suppuration, acute iridocyclitis, slow and prolonged uveitis, all classes of iris complications, hyalitis, glaucoma, detachment and degenerations of the retina, etc. Major Smith in several large series of such extractions reports vitreous escape varying between 6 and 8%. Herbert says, "No other operator has succeeded in approaching this low percentage." Of the hundreds of skillful ophthalmic surgeons who have attempted the operation few have reported as low as 25%, and most of them something between 30% and 50%. While the same surgeons, operating in the usual manner, with capsulotomy, have kept the percentage down to from 1 to 6%.

2. **Rupture of Capsule.**—No matter how clever the operator, he can never be certain of delivering the lens with its capsule intact. At the hands of Major Smith himself the capsule breaks in 5 to 8% of cases—at those of others in 16% and upward. If, as most often happens, the capsule must then be left in the eye, the conditions are worse than if ordinary extraction had been choosen. For it must be remembered that the rupture occurs in most instances when the cataract is nearly delivered, that is, when the zonule has been torn away from its supports, thus leaving the capsule free to get into the corneal wound. This leads to delayed union. It is likely, too, that the abandoned capsule contains cataract matter, and the whole forms a crumpled mass, more potent for trouble, perhaps, than the smooth encapsuled cortex remaining after other methods.

3. **Iris Complications.**—Owing to the relatively great frequency of vitreous loss, also to the extent of the primary incision, the propor-

tion of prolapses, incarcerations, retractions, inversions, and distortions of the iris is inevitably greater with this kind of extraction. If vitreous has presented or escaped, it makes impossible the reposition of a prolapse either at the time of the operation or afterward, and it just as effectually prevents dealing with the pillars of the coloboma that are more often caught by the incision in the "Indian" operation.

4. **Toilet Difficulties.**—Ophthalmic surgeons are practically a unit as to the great importance of a finished toilet after extraction. This means not only replacing of the iris, but seeing that there is nice coaptation of the lips of the wound, that the conjunctival flap is in its place, and that there are no shreds of fibrine clinging to the incision. And, lastly, it means a gentle douching of the conjunctival sac. None of these things can be properly done if vitreous has escaped. Even in the more successful instances, the absence of the support afforded by the zonule and capsule, together with the large coloboma and the extensive incision, make it risky to perform a proper toilet.

5. **Technical Difficulties.**—That the operation makes greater demands not only upon one's skill, but also upon one's judgment, upon the sense of touch and upon that almost intuitive sense, which, when exercised to the fullest, is so much to be relied upon in averting disaster, all are agreed. Many of the difficulties hinge upon knowing how much pressure is required, and where best applied to loosen the lens or the zonule from its attachments, and to follow it up in the safest and surest manner till the cataract is delivered. Several have confessed to having, on occasion, failed to deliver the lens, notwithstanding an ample incision, because the degree of pressure required was greater than they dared to make; so they desisted and had recourse to capsulotomy.

6. **Injury to the Cornea.**—The considerable and prolonged rubbing and trituration of the cornea with the blunt hook, which is a part of the technic, cannot but be deleterious to that membrane. Dr. Greene, of Dayton, the foremost exponent of the operation in this country, told the writer that he had changed the site of said rubbing, etc., to the sclera-corneal junction or beyond it, in consequence of having observed traumatic keratitis after some of his Indian extractions.

7. **Unsightliness.**—The frequent loss of vitreous, with its drawing effect upon the iris, the leaving of the iris caught in wound and the big coloboma, made yet greater through these influences, all combine to make a very ugly eye; though this is doubtless less of an objection among the dark faces and dark irides of India than among white people.

8. **Expulsive hemorrhage** is said to occur oftener after intracapsular extractions, which, in view of all the circumstances, is not to be wondered at.

9. **Postoperative astigmatism,** according to Czermak and others, is more pronounced after this method.

When the time arrives that the average operator can rid the eye at once of cataract, sub-capsular cortex, and capsule with as little ultimate damage to the integrity of the organ as it now incurs from the best chosen of other methods, opthalmic surgery will have made an enormous step in advance. That such a time has not arrived no one can deny, and few perhaps are so optimistic as to believe that it is near.

Suction or Aspiration.—Next to reclination this is the most ancient means of ridding the eye of cataract, though applicable only to the softer kinds. It is said to have been practised in some of the Asiatic countries, as Persia, in very remote times, while it is certain that the Arabians employed it early in the Middle Ages. It consisted originally in introducing a hollow needle through the sclera into the lens and, by some means of suction, usually the mouth, evacuating the cataract. At times a small incision was first made through which to pass the canula. Early in the past century it had found favor in the eyes of the Italian surgeons, one of whom, Pecchioli, improved on the older method by first making keratonyxis (discission) and after the lens matter was well broken up, inserting a hollow needle and aspirating. In England, during the early sixties, the operation, for a few years, numbered among its proselytes such distinguished men as Teale, Lawson, and even Bowman. The last-mentioned invented an aspirator for the purpose (Snellen).

The last revivals of it were in Brussels, Belgium, about 1875, by Coppez and by Redard, the latter of whom, as recently as 1887, devised an aspirator which did away with the reversed syringe, as the suction engine, reverting, in this particular, to the ancient type and

substituting the mouth. By its advocates the method was deemed proper for just the class of cataracts for whose removal the surgeons of to-day make either discission or linear extraction, viz., recent traumatic cataracts, the yet unexplained soft cataracts of young children, and those that occur spontaneously in adults under middle life.

Couching, depression, reclination, displacement, abaissement, are all terms used to denote the most ancient form of cataract operation—so ancient, indeed, that the tracing of its origin is lost in the remotest antiquity. It may be mentioned that Willburg, of Nuremberg, had in the year 1785 advised a form of reclination and depression, which was to turn the lens straight over backward, the hinge being directly below so that it rested, anterior surface upward, on the lowest segment of the ciliary body. There were two methods of making the ancient operation—one by introducing a thorn or other needle-like instrument through the center of the lower segment of the cornea (*keratonyxis*) obliquely upward through the pupil into the middle of the upper segment of the crystalline, elevating the handle, with the cornea for a fulcrum, and thus forcing the cataract directly down, without turning it, between vitreous and ciliary body. The other accomplished the same result, but the instrument was thrust into the lens through the sclera (*scleronyxis*) near the horizontal meridian, six or eight millimeters back of the sclero-corneal junction. Wilburg punctured the sclera in the horizontal meridian, and four or five millimeters from the limbus, with a flat needle which he guided between the iris and capsule, preferring rather to hug or even to tear the latter, in order to avoid the iris. He then applied the flat of the needle to the front of the lens, above its middle, and tipped it over backward.

Depression, discission, and suction remained the only surgical measures ever undertaken for the relief of blindness from opacity of the crystall ne until Daviel hit upon a better. Yet, strange to relate, after more than fifty years, the progress of the operation for extraction had been so slight that in the last years of the 18th and the early years of the 19th century this primitive method of depression had staunch defenders among the most renowned ophthalmic surgeons—Richter, de Wenzel, and Beer.

During the first decade (1803) of the last century, Scarpa gave a

fresh impulse to its popularity by so modifying the operation as to turn the cataract downward and outward, so that it lay with its anterior surface inward and its posterior against the infero-temporal portion of the ciliary body (true reclination), instead of pushing it straight down into the vitreous (true depression), as his predecessors had done.

The last of the great champions were Sichel and Desmarres, beside many others of lesser fame. Not because they lacked personal knowledge or experience with the discovery of Daviel—for they had, for the most part, labored faithfully and perseveringly to give it the precedence it deserved—but for the reason that the immediate results of the procedure were disheartening. They naturally returned to the method by which they were spared the oft-recurring visitations of suppuration—that incubus of the earlier eye-surgeons—notwithstanding the fact that the ultimate benefits were even then vastly in favor of extraction. For, sooner or later, most of the lenses dislocated into the vitreous caused serious disturbance, detachment of the retina, various forms of uveitis, etc., or the sight restored by the operation was subsequently lost again by the reappearance of the cataract at its normal site—not an infrequent event.

Since, in the opinion of certain ophthalmic surgeons, the operation of reclination, or couching, is not altogether obsolete, a description of the most recent mode of performing it—that of Scarpa—may not be amiss.

The following instruments are required; blepharostat, fixation forceps and a stop-needle similar to Bowman's, only slightly curved on the flat, the distance from the point to the shoulder, or stop, being about one centimeter. According to usage, the surgeon and patient (the latter with pupil dilated) sit facing each other, though there is no good reason why an operating-table should not be used. The lids are propped open, the globe is steadied in the usual way, and the needle, with its convexity directed upward, is entered at the temporal side, four millimeters back of the sclero-corneal junction, and very slightly below the horizontal meridian. Thus, the long axis of the wound is placed in a meridian of longitude, insuring the minimum of traumatism to the ciliary zone. As soon as the spear portion has entered completely the posterior chamber,

the convexity of the shaft is turned forward, the instrument pushed inward, either between the posterior surface of the iris, or, which would be more likely—seeing the space is *nil* or very slight—beneath or through the anterior capsule itself. Then on until the point nears the inner border of the pupil, somewhat above the center, or until the stop touches the sclera. Holding the stop firmly against the sclera, as a fulcrum, a movement of the handle is made whereby the cataract is swung out and down so as to rest with its posterior surface between the insertion of the external and that of the inferior rectus.

Having pressed the cataract lightly down against the ciliary body and choroid, it is held so for a few moments, the better to insure its remaining there, the movement of the handle is reversed and the convexity of the needle brought back against the iris, when a pause is made lest the lens bob up and have to be depressed a second time. The quarter turn is made to again put the convexity upward, when the instrument is withdrawn in the same position as when introduced. Among the immediate accidents of the operation were dislocation into the anterior chamber, the breaking up of the lens, and the entanglement of the needle in iris or nucleus of the cataract.

When the first fruits of the labor of v. Graefe and his disciples with the linear method became apparent, the day of reclination began to decline. It grew darker and darker with the perfection of the flap extraction, and it was totally eclipsed in Europe and America by the advent of aseptic surgery. It is still extensively practised by native surgeons in several of the Asiatic countries.

Captain Henry Smith[1] reports having extracted sixty-nine cataracts from the eyes of natives of India that had formerly been couched and afterward rose to obstruct the pupil. One could imagine circumstances under which the operation would still be admissible.

Discission.—This operation, which consists in puncturing or cutting the lens with a needle or a small knife, like that of depression, is also of very ancient origin, and was mentioned by Galen as having been practised by the "ancients." Indeed, the idea was but the natural outcome of the displacement measure, seeing that in case the lens matter was liquid, or only semisolid, and the

[1] Ind. Med. Gaz., xxxvi, p. 224.

depression needle entered the capsule—which by design or accident often happened—the cataract would disappear by absorption. Hence acupuncture would, as it really did, become the logical treatment for those soft cataracts that were not suitable for depression.

Ambrose Paré gave new life to the operation, calling it *sclerotico-puncture*, for the needle was introduced by way of the sclera until 1797, when Conradi,[1] a pupil of Richter, devised the modern route through the cornea, and, under the name *keratomyxis*, the operation became general. Langenbeck[2] was the first to employ a mydriatic—belladonna—in this connection, which greatly facilitated matters. The sphere of the operation is at the present time limited to soft lenses, such as the recent or undegenerated traumatic and all the cortical cataracts of young or relatively young subjects, the transparent lenses of high myopia, those congenitally displaced, and, in a somewhat modified form, to secondary or after-cataract. The operation also has a small field of usefulness for congenital zonular or lamellar cataracts in children and young adults. It may be stated, in passing, that the surgical treatment of these cases is not attended with the same degree of satisfaction as that of other varieties. If the zone of opacity is small, not larger than a good-sized pupil, the best operation is optical iridectomy, preferably inward and slightly downward. It is only when the area of the cataractous circle is large that a lens operation is to be considered. Then it becomes a choice between one of the forms of extraction and discission. For my part, I prefer the latter, although it may mean three to five repetitions, the last of which is usually a dilaceration of dense membrane.

The time of life beyond which discission of cataract, that would appear to be moderately soft, is impracticable has not been definitely decided upon. Certain it is, however, that the age once fixed as the limit has been more than doubled. Knapp[3] mentions having made the operation with success in the eyes of persons thirty-seven. The case cited below, in which discission was made for high myopia, is a shining example of its feasibility at thirty-five and thirty-six.

[1] Arnemann's Magazine, 1797, i, p. 61.
[2] C. J. M. Langenbeck, Bibl. f. Chirurgie, 1809.
[3] Norris and Oliver's "System," vol. iii, p. 811.

Mrs. J. K., age 27, Jewess. Seen first Jan. 5, 1892. High myopia, right; high myopic and astigmatism, left. Had been cured of trachoma and vascular keratitis. Conical cornea in both eyes. R. V. = 2/200; 20/100 + 1 w − 20 D. L. V. = 5/200; 20/100 + 1 w − 15 s ⊃ − 5 cyl. ax 135°. Under atropin the following lenses were prescribed: Right − 18 D; Left, − 15 s ⊃ − 5 cyl. ax, 135°. Saw patient no more until Nov. 14, 1899. Age now 35. Test then showed;—R. V. = 2/200; 20/100 w − 25 D; L. V. = 4/200; 20/100 + w − 20 s ⊃ − 3 cyl. ax 150°. Advised discission which was done in the right eye, Dec. 15, 1899.

The first operation consisted in a mere pricking of the anterior capsule. Little or no effect. One week later a bolder discission. Lens slowly disappeared. To be brief, the first or slight operation on the left eye was made Oct. 11, 1900. The patient was now 36 years old. By Feb. 1, 1901, the lens had entirely disappeared. The remarkable features of the case are the prompt absorption of the lenses following the second or thorough discissions and the ultimate refractive and visual results, which in September of 1903, were as follows: Right eye, with − 4 cyl. ax 120° V. = 20/20 + 4. Left eye, with − 2.5 s ⊃ − 2.5 cyl. ax 110° V. = 20/30 + 1. For reading, added + 3 and + 2. The corneal cones, in consequence of the operations and the prolonged bandaging, had in great measure subsided.

Many of us have seen ready absorption in much older persons after traumatism of the lens. A striking instance once came under my observation. A machinist, aged 49, was struck in the eye by a flying chip of brass. The man came immediately for treatment. A thin sliver of the metal was seen with its proximal extremity within the anterior chamber and its distal buried deeply in the crystalline. It was removed through the enlarged corneal wound. Absorption of the resulting cataract was affected in an incredibly short space of time, and good sight was restored to the eye.

In my service at the Illinois Eye and Ear Infirmary, about two years ago, I made discission for cataract in case of a woman past 45—first upon one eye, then upon the other. The first cataract disappeared promptly. The loosened hard nucleus of the second fell into the anterior chamber causing some irritation, and was extracted through a small linear (lance) incision by means of a sharp hook. The result was perfect in both eyes.

True, after the disappearance of all the cortical portion of the lens, in subjects verging on, or actually in, middle life, a tiny hard nucleus may occasionally drop down either behind or in front of the iris, and there become the source of considerable irritation. But this can be easily extracted through a small incision with the lance keratome by means of the open sharp hook. Fortunately, these dense lens remains usually fall into the anterior chamber, where they are less provocative of harm and whence they are extricable with less risk and difficulty than if located in the posterior

chamber. In the latter situation even a small nucleus can excite secondary glaucoma, as I have good reason to know by recent experience with such an instance relative to a thirty-year-old man. In the event of the nucleus having dropped down behind the iris it might be got into the anterior chamber by placing the patient on his stomach upon an operating-table, with the head hanging over the end and so manipulating and jarring it as to cause the nucleus to enter the front chamber by gravity.

These facts, together with the added confidence inspired by the use of the Graefe knife and its insertion at the base of the cornea, have led me of late years to make discission in a number of cases for which formerly only extraction would have been thought of.

The great majority of operators make true keratonyxis, using some form of needle or combination of needle and small knife—Knapp's for example—and pierce the clear cornea two or three millimeters from the limbus. Following the most worthy example of H. Pagenstecher, the writer has for a number of years, and with ever increasing gratification, substituted a small model of the Graefe knife for the needle, and instead of going through clear cornea, enters the instrument at the limbus or a trifle back of it. The following will suffice for a description of the operation in general, the surgeon making his choice of needle, knife-needle, or Graefe knife.

Operation.—The pupil having been previously dilated, the patient is placed either upon an operating-chair or upon the table. The operator, if he be ambidextrous, stands behind the chair or at the head of the table for either eye, manipulating the knife with the hand which corresponds to the eye in question. Otherwise, in operating the left eye, he stands on that side with his own left side against the chair or table. The instruments are the blepharostat, fixation forceps (without a catch) and a Graefe knife whose blade is somewhat smaller than that of the average or regulation pattern, and very sharp both as to point and edge. Recently at the Eye and Ear Infirmary, while speaking of the requirements of the knife for discission, one of the internes, Dr. Fullenwider, suggested removing the cutting quality of the blade, save for the part to be actually engaged in the capsule and lens. The idea was so rational that I have since had put in order, for this purpose, a knife whose edge

is sharp for only six or eight millimeters from the point. With this, wounding of the iris and needless cutting of the base of the cornea with undue escape of aqueous are avoided. The illumination is either daylight or artificial, focused on the eye through a large lens. A drop or two of 4% cocain solution is instilled, and after a wait of five minutes the blepharostat is put in place, the eye is flooded with warm boric acid solution, the excess of which is sponged away.

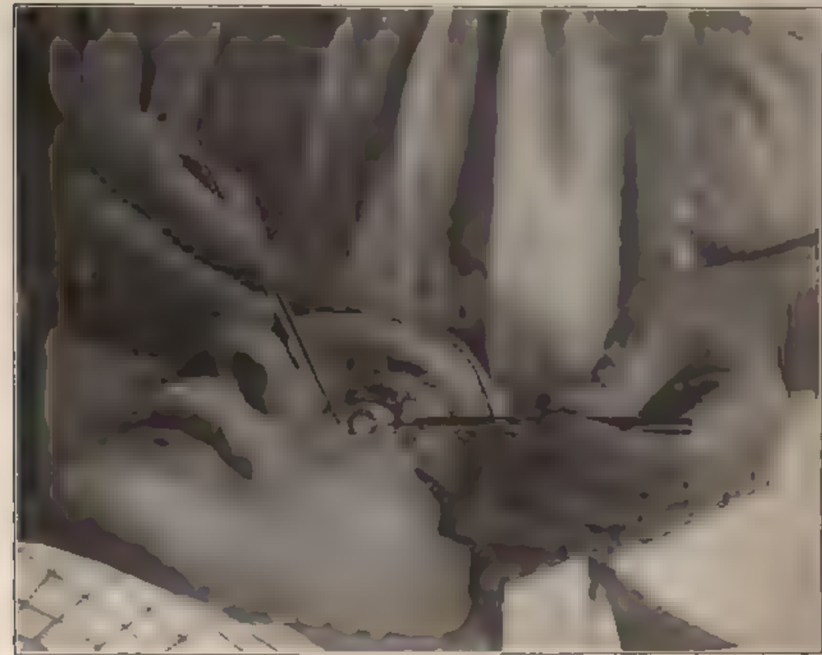


FIG. 247. Discission.

A good firm hold is taken of conjunctiva and episclera with the fixation forceps close to the limbus on the nasal side; the knife is made to perforate the cornea (edge toward the operator) exactly in the outer sclero-corneal junction, encroaching even on the conjunctiva, in the same manner as in making the puncture for flap extraction (Fig. 247). It is pushed in, following the plane of the corneal base, until the point is opposite the center of the pupil, when, if it be the first discission in the case, the handle is raised and the center of the capsule merely punctured. If not the first, the

point of the knife is made to swing in the central meridian of the lens till it approaches the pupillary margin just across from the operator—below always with the ambidexter—the handle elevated, and the blade pushed slantingly into the lens substance, taking care not to go through the posterior capsule. The handle is then rotated away from the operator and a free incision is made in the crystalline. The knife is now once more put into the horizontal position, as on entering, and rapidly withdrawn. This last move would better be a quick jerk which best assures what is most desirable, viz., the leaving behind of aqueous, shreds of capsule, and particles of the lens.

Before abandoning the needle or knife-needle and the puncturing of clear cornea in making this operation, I had come to regard the operation of discission as being quite as formidable as that of extraction itself, whether undertaken for cataract or pupillary membrane. Statistics prove that it is really a dangerous operation. Hardly an operator of fair experience but has had at some time very serious reaction follow "a simple needling." The perils incident to the ordinary needle operation were strongly brought out and emphasized by the well-known, world-wide inquiry of Landolt, instituted some years ago.

Since adopting the Graefe knife and the extreme peripheral place of entry, the procedure has to me lost all its terrors, and I no longer hesitate to make as many repetitions of it as are needed in a given case. The reasons for the superiority of the knife, modified as stated above, are:

1. The cross-section of a properly made modern modification of the Graefe knife is an ever-increasing wedge which, while entering without a jog, effectively keeps back the aqueous.

2. It cuts better than the needle or knife-needle, both of which mostly tear, and the edged portion, having some length, allows more leeway, i.e., the blade may move slightly in or out, yet still be enabled to cut the capsule. Best of all, it permits one to impart to the blade that delicate, almost imperceptible, sawing movement so essential to incision—especially desirable with membranous cataracts.

3. All the trenchant needles have round shanks whose diameter is smaller than is the width of the blade, making a sort of shoulder where the two meet, so that they ream out a hole and permit the

aqueous to escape. This, in view of the changed character of the aqueous that is secreted after sudden evacuation of the anterior chamber—i.e., that it is much richer in albuminoid substances—renders it highly desirable that there be no escape during the operation. With the method in question one is able to make a number of discissions, both for primary and secondary cataract, without ever losing a drop of aqueous. Again, the trenchant needles go into the anterior chamber with a start that is apt to carry them too far, and they come out with a pop, and are prone to pull bits of capsule into the corneal opening, there to lie inviting infection and preventing healing.

The advantages of the peripheral point of entry, or conjunctival route over that which is further in, are:

1. It lies in the vascular zone where closure and healing are immediate.

2. It affords the opportunity of penetrating the cataract or capsule in a very slanting manner, which makes the act of cutting more positive and makes it easy to avoid going through the posterior capsule and wounding the vitreous.

If, for example, one wishes to cut a sheet of paper with a knife, his task is much easier if he holds the blade at an acute angle with the plane of the paper than if held at or near a right angle.

Bandaging for twenty-four to forty-eight hours after the operation, and atropin throughout the treatment, constitute about all the needed after-measures in most instances.

ACCIDENTS AND COMPLICATIONS.

Like those incident to extraction, those after discission are both immediate and consecutive, though by far the most serious pertain to the after treatment.

Among the more frequent **immediate accidents** are wounding of the iris, premature escape of aqueous, rupture of zonule (dislocation) injury to the ciliary processes by tugging and tearing, plunging the instrument into the vitreous, and, as already referred to, the dragging of portions of capsule lens or vitreous into the corneal wound. The best means of avoiding them, while in the main quite obvious, do not, even as regards the most skillful, always keep them

from happening. Perhaps the greatest *desideratum* is that the point and edge of the knife be *as sharp as it is possible to make them.*

With regard to the **consecutive accidents**—or the reactive processes—so far as they go, they are, with one exception, the same as follow extraction, being iritis, iridocyclitis, and pus infection, and require the same treatment. The exception alluded to is glaucoma, caused by the swelling of the lens matter after incision of a soft cataract or of the transparent crystalline. If the subject of such an operation is under 30 years of age, this is not an uncommon occurrence. Hence, in operating for the first time in a given case, the cut in the capsule should be purely tentative—a mere pricking of the capsule. Next time, there having been no special reaction, the effort may be bolder. Often a lens will rapidly disappear from a tiny puncture. But they must all be closely watched, and at the first signs of high tension an incision made with the keratome and as much of the lens matter got out as is practicable, holding the iris back with the spatula as indicated (p. 494).

Of course, escrin may be tried, but *unless the tension subsides within a very few hours, the extraction must be made, else the sight is jeopardized.* If the patient is timid or nervous, a general anesthetic would better be administered for the extraction, as the tension and hyperemia are bars to local anesthesia. The consequences of a linear extraction are not nearly so much to be dreaded as a few days of secondary glaucoma. Fukala, the originator of operations upon the lens for high myopia, states that latterly he makes discission in these cases, expecting later, when breaking up and swelling of the crystalline occurs, to make extraction.

Secondary cataract, after-cataract, capsulo-lenticular cataract, membranous cataract, all refer to some form or degree of opacity, occurring in the pupil after the lens proper has disappeared. It may be the result of accident (traumatism) or of one of the surgical measures, extraction or discission. The first are more rarely met with, the second, the busy ophthalmic surgeon encounters constantly, and it is to these, therefore, that this chapter chiefly relates.

It is composed of varying masses of encapsuled, normal or degenerated lens matter, the remains of the lens capsule, more or less thickened by proliferation of its endothelium, and particularly

when there has been inflammatory processes in connection with its formation, the addition of a certain amount of organized plastic material. Their density varies from that of a web so delicate as to be invisible by ordinary means to that of a mat so thick and compact as to exclude any but strong light from the depths of the eye; yet between these two extremes it is present, to a degree, in practically all eyes after removal of the lens. Even the extraction of the lens in its capsule, though it leads less often to secondary operations, does not do away with them altogether.

When one considers the different views of leading eye surgeons as to the relative frequency of operable secondary cataract, one is at a loss to explain their great disparity. As Panas puts it, "Between Knapp, who advises discission in every case (after extraction), and Gayet, who intervenes only exceptionally, one must know how to choose a golden mean." This, however, is putting it rather strong, for Knapp acknowledges to making the operation in only 70% of cases. The degree of amblyopia produced by the after-cataract is what should determine whether or not a discission be made. Knapp does not operate if the visual acuity is above 20/50. Certainly, the secondary operation is called for if the vision is 20/70 or less in consequence of the membrane.

As has already been stated, the principal cause of secondary cataract, at least of the kinds that call for operative interference, are abandoned lens masses that remain adherent to, or entangled in, the capsule after extraction, and are specially prone to follow such operations upon unripe cataracts. Add to this the other causes of inflammation, such as indiscriminate laceration of the capsule, bruising, tearing and incarceration of the iris, and we have not much further to seek for the origin of consecutive membranous cataract.

Hypermature and sclerosed cataracts, although they sometimes present certain mechanical difficulties in delivery and are subject to the same inflammatory reactions, expose one less often to secondary cataract than the forms before alluded to. Here truly an ounce of prevention is better than a pound of cure. Having a knowledge of the conditions that are chiefly instrumental in the production of secondary cataract—as well as of the fact that, notwithstanding the greatest skill in making the primary operation and the utmost care in the after-treatment, either a considerable number of supple-

mentary operations or some grade of blindness is inevitable—our management of the case may be such that it will not only materially diminish the chances of secondary cataract, but it will also put us in better position to cope with it when it does occur by leaving the eye more nearly in its normal state.

As to the length of time that should elapse between the extraction and the discission, no definite period can be fixed. It is not prudent, in any case, to interfere while there are any remaining traces of irritation from the primary operation, because of the liability of the opening in the membrane to speedily close again. It would be well to wait from one month to six weeks after the most favorable recovery from the extraction. From then on the operation may be made at any time. Then, too, there is great variation in the time at which the secondary cataract begins to dull the sight. The latter may remain good for several months or even several years, then fail from this cause. However well-timed the "needling" or successful, it does not insure against the necessity for another at a later date.

There are several surgical measures that are employed to free the pupil when obstructed in this manner, and the choice of one will depend upon the character of the membrane in question. In most instances, it will be some kind of discission or incision, seeing that this is the simplest and safest means, and quite as effectual as any for the usual thin variety of after-cataract. Having decided upon discission, then, we will say, what sort of instrument shall we use for the cutting of the membrane? For, as its name implies, the operation is one of *cutting*, not *tearing*. It must of necessity have a trenchant edge. Now, this the ordinary spear-pointed needle, used by so many operators, possesses, it is true, but in a very limited degree, and its wound, instead of being a clean incision, is a jagged rent. One of the knife-needles is a far more suitable instrument, and Knapp's is the best of these. My preference is for the Graefe knife, selected and prepared as described in the chapter on Discission, and for the same reasons as there given. The other instruments are the same as for discission in general, viz., blepharostat and fixation forceps.

The pupil is dilated as widely as possible. The illumination of the field of operation, for the whiter or denser membranes, may be

bright daylight, but for the thinner or less conspicuous ones a stronger is required, such as the focusing on of the light of an Argand burner or that of a ground incandescent electric bulb by means of a handglass. Another good light is that of the portable electric bull's-eye thrown onto the eye from one side by an assistant. If oblique focal illumination is employed, the assistant must be careful not to focus on the eye a sharp image of the flame, but to have it a trifle within or beyond the focusing point, as this gives a more even and a larger area of light. Also a little unsteadiness will not be so apt to cause it to fail the operator at the critical moment.

The eye, the instruments, and the operator all having been as scrupulously prepared as if for an extraction, excepting that only one or two drops of 4% cocain solution are required, in what manner shall the membrane be divided? According to the principles stated on page 560, the knife must be entered at the limbus, but the precise point of entry must be governed by the formation of the membrane with which we have to deal—in other words, by the position and the direction of the denser bands which compose it, for these cataracts are never of uniform thickness or opacity throughout. It will be found a great help to study each membrane by strong focal illumination and a magnifying glass or with the ophthalmoscope and transmitted light beforehand. The streaks more often run crosswise or obliquely than vertically, at any rate, after the peripheral capsulotomy, so that the knife is best inserted at some place along the outer corneal limbus farthest from the ends of the more prominent bands in order to cut athwart them. Here it is of the greatest advantage to be able to wield the knife with either hand, as should the portion about which one is most concerned, lie horizontally and near the upper border of the right pupil or the lower border of the left, it could be more easily divided and with less risk of injury to the iris and ciliary body by holding the knife in the left hand. Assuming that the bulk of the opacity is vertically across the center of the right pupil, the operator stands facing the top of the patient's head with the knife in the right hand (edge up), and the puncture is made in the horizontal meridian at the limbus, and precisely as if for extraction.

The point is pushed in, horizontally, just above the iris, till it is

opposite the center of the pupil, the handle is rotated in the horizontal plane toward the operator to bring the edge below the thicker bands, or the back of the blade is made to approach the lower pupillary border. The handle is elevated (in the vertical plane) and the point made to pierce the cataract very slantingly, then the handle is depressed (in the horizontal plane) making the blade cut upward until the incision nears the upper pupillary border, when the last movement of the handle is reversed, to bring the blade again to the horizontal, and suddenly withdrawn, meanwhile holding the eye very firmly with the forceps.

The elasticity of these membranous cataracts is sufficient, in most instances, to convert the incision into an oval opening. Moreover, there are many times a number of tiny posterior synechia so that the mydriasis produced by the atropin tends also to stretch open the cut. There is one rather singular feature relative to the behavior of the membrane, which is occasionally shown when engaged by the edge of the knife, that it is well to bear in mind. Instead of dividing at once, it will allow itself to be pushed along, doubled over the edge, and seem not inclined to yield; but simply stop the progress of the knife. Wait for a moment, and the severed bands will be seen to fall away in a clean incision. No decided sawing is needed. Whether it is the fine tremor of the hand which holds the knife or the insensible movement of the eye, something acts to induce this final parting. As before stated, however, the smallest of sawing motions best insures a prompt and smooth incision, and this can be easily and safely accomplished with the knife here employed.

Now and then, previous to extraction, there has been a thickening of the central portion of one or both capsules, and the ensuing secondary cataract is not of the kind that can be easily incised, being frailly connected with the zonule and most resistant just where the cut should be faultless. The same is true of that variety of congenital cataract which is composed of a mass of connective tissue or the latter mixed with chalk. If one succeeds in the discission, the two sides are apt to fall together again and reunite, or the whole mass is merely pushed to one side without being at all divided. It afterward drifts back, and the operation counts for naught. It often happens, however, that a simple discission answers perfectly

in just such a case, and it is, perhaps, best to make at least one trial of this method before resorting to a more complex one.

Posterior Discission.—Much has been said concerning this procedure, devised some years ago by Da Gama Pinto, of Lisbon. It consisted in incision of the membranous cataract from behind by a knife passed through the sclera. The method has had few supporters. It was advocated, however, at the Lucerne Congression in 1904 by no less a personage than De Lapersonne, successor to Panas, who then described his technic and a special knife for the operation. At the same meeting Da Gama Pinto himself stated that because of having observed two cases of detachment of the retina after the procedure, he had abandoned it, and had returned to the anterior method, using Knapp's knife-needle.

Arrachement.—Having failed, recourse may be had to plucking out or tearing out (*arrachement*) of the membrane. This consists in making, first, a small moderately peripheral corneal incision with the lance-knife, inserting thereat a pair of capsule forceps and pulling out the thickened membrane; or making use of the small blunt hook and proceeding exactly as described in case of the congenital cataract cited on page 557.

Dilaceration has for its end the creation of an aperture permeable to the rays of light in the center of a cataractous pupil by rending and prying asunder the opposite halves of the obstruction. It is applicable to almost any of the thicker secondary cataracts, but peculiarly so to those very thick, tough, and *adherent* ones that sometimes follow absorption or partial absorption of the lens due to severe injury; as also to those that come after operations for primary cataract that have been attended by accidents or succeeded by inflammatory reaction. The chief advantage of dilaceration over discission is that it obviates any injury to the ciliary processes from dragging.

The method usually employed is that devised by Sir William Bowman,[1] and is known as *Bowman's Double Needle Operation.* The instruments are lid speculum, fixation forceps, and two delicate sharp stop-needles. If possible, the pupil is dilated. The lids are propped open, the eye douched with warm boric acid solution, the globe steadied with the forceps, held in the left hand, and one

[1] Med. Times and Gazette, 1852.

needle passed through the cornea, in the horizontal meridian, about two or three millimeters from the limbus, and the point pushed into the center of the cataract. The eye is now steadied by the needle, the forceps is dispensed with, and the other needle is similarly inserted on the opposite side and its point also made to enter the center of the cataract. If the two needles are properly adjusted, their two spear-shaped blades will lie flatwise, one against the other, in the horizontal plane of the eye. Now the two handles are made to approach each other, thus separating the points, like opening the blades of a pair of scissors, until a satisfactory orifice is torn through the cataract. A pause is then made in order to fix the fragments, then the first movement of the handles is reversed, and they are withdrawn in the same sense that they were entered. The distance from the point of the needle to the shoulder or stop ought not to be so great as to allow deep wounding and stirring of the vitreous for fear of exciting a hyalitis. Eight millimeters to one centimeter is ample, and twelve milimeters, which is a common length, is too great.

The after-treatment of discission, arrachement, and dilaceration is, as a rule, neither long nor eventful. Immediately the operation is completed, the eye is dressed in the same manner as after extraction. The patient may be permitted to walk from the operating-table to his room. At the end of twenty-four hours the eye should be inspected, and if all signs are propitious at the end of forty-eight hours, a shade or medium smoke coquilles may be substituted for the dressing. It is wise to insist that the patient be moderately quiet and free from exposure for some days and that he does not pass from observation under ten days or two weeks.

Division with Scissors.—There will always be a small class of after-cataracts to confront us that is adapted to none of the methods just described. Where the cataract is quite dense and attached to the iris or where the pupil is much misplaced outward from the center or much contracted. In fact, the conditions are very similar to those that call for iridotomy. Here some form of tiny scissors may take the place of needle or knife. This necessitates the making, first, of a fairly extensive corneal section, which is accomplished much in the same manner as for iridectomy, the difference being that it is desirable to make a small opening in a given part of

the cataract at the same time, in order to give ingress to one blade of the scissors. When it is not practicable to utilize the keratome in this way one must have recourse to scissors having at least the under blade provided with a keen point with which to start the cut in the capsule. The corneal incision is so located as to lie parallel with, and accessible to, that portion of the membrane which is to be divided. A steep puncture is made with the lance keratome in the exact sclero-corneal junction, and, if possible, the opening is made in the cataract with the same forward thrust of the knife; when not possible or feasible, the blade is partly withdrawn, its point placed at the spot for the opening, and again pushed forward. Having failed in this, the sharp blade of the scissors may be used. In any case the thinnest part of the cataract is chosen for the opening. It is important that the scissors be extremely delicate and of exceptional sharpness. De Wecker's ordinary model is entirely too large. Those shown in plate VII, No. 86, are suitable, or the straighter ones, No. 85. The scissors are passed into the anterior chamber closed, then opened, and the lower blade made to enter or to cut the opening in the cataract, and to further divide it as wished. If cutting in a single direction does not seem to give a sufficient pupil, a second snip may be made diverging from the same point of entrance into the membrane, or, provided the original opening in the capsule, as made with the keratome, is long enough, two convergent snips may be made, and the triangular piece thus excised be extracted with the iris forceps (see Kuhnt's and De Wecker's iridotomies). Seeing that loss of vitreous is the bugbear of this operation, the Angelucci fixation, described on page 542, is most appropriate, as it serves effectually to fix the globe, while, at the same time, it tends to hold the corneal wound closed, thus keeping back the vitreous. Any one of the four recti tendons may be grasped, so long as it is on the same side of the cornea as is the location of the keratotomy. It is essential that both eye of patient and hand of operator be perfectly steady.

ARTIFICIAL RIPENING.

The extremely slow development of some species of senile cataract, especially after the time when the sight has become greatly interfered with, has always been a source of grievance to which both patient

and surgeon have been victims. Especially is this true of certain incipient nuclear cataracts, with which is associated a high degree of amblyopia, yet hardly any visible opacity, even of the lens center, and the cortical portion is perfectly transparent. Owing to the considerable difference between the index of refraction of these two portions, the vision may be reduced to the counting of fingers at a distance of two feet—barely sufficient, under favorable conditions, to go about with, yet by looking in with the ophthalmoscope, a fairly bright reflex may be got through the center of the pupil without, however, any details of the fundus. But with the pupil widely dilated and looking through the periphery, the optic nerve and the vessels of the retina can be defined with tolerable clearness. In other words, it is not so much the transmission of light that is interfered with, as that the retinal image is spoiled by diffraction. This state of the lens may persist with little or no change for an indefinite period. Then there are the irregular forms of cortical cataract that are often equally tedious and troublesome.

The methods employed or devised to hasten the ripening of these immature cataracts may be divided into four groups:

I. **Discission** of anterior or posterior capsule or of both anterior and posterior capsule of the lens.

II. **Massage,** either *indirect* through the cornea (the anterior chamber having been evacuated), or *direct* immediately upon the lens.

III. **Intracapsular injection** of *aqueous humor, normal salt solution*, or other liquid.

IV. **The External Application of Heat to the Eye.**

I. As early as 1811, Gibson, of London, tried discission a few days previous to the linear extraction as a means of hastening the maturity of cataracts of this kind. This he did for the dual purpose of causing rapid opacifying of the outer cortex and, through the entrance of the aqueous humor, the loosening of the lens substance from its capsule. Muter, in 1815, resorted to similar practice. On account of the subsequent swelling of the lens and the generally unsatisfactory extraction which followed, the procedure was not popularized; although forty years later, in 1858, Moren, of Heidelberg, again proposed this method for the artificial ripening of cataracts.

In 1864, v. Graefe[1] endeavored to improve upon the method by making three operations in succession. First, an upward iridectomy. Second, after some three weeks, a crucial opening of the anterior capsule with Bowman's needle. Third, after several days, a flap extraction. His aim was twofold—rapid maturation of the cataract and, through the proliferation of the endothelium of the capsule, to cause a loosening from it of the cortex. The end did not justify the means.

Twenty years after the introduction of the v. Graefe operation, Stellwag, in 1886, proposed the discission of the posterior capsule by means of a scleral puncture. This suggestion was modified by Businelli in 1888, who proposed discission of both anterior and posterior capsules.

II. Seventeen years after v. Graefe modified the simple discission for maturation of cataract, another method was devised by Foerster,[2] of Breslau, which had a host of imitators and modifiers and inaugurated a veritable boom in this line. This surgeon made a preliminary iridectomy and immediately, while the anterior chamber was empty and the crystalloid was in contact with the cornea, made massage through the latter by means of the back of a Graefe hard-rubber spoon or the heel of a strabismus hook; then, after a few weeks, the extraction.

The omission of the iridectomy and indirect massage through the cornea, after evacuating the anterior chamber by means of a simple puncture, was recommended by Meyer at the Copenhagen Congress in 1884. In 1885, direct massage of the lens itself was advocated by Rassander, and a little later (1888) Bettman, of Chicago, performed a similar operation with an instrument of his own design. Direct massage was accomplished by following the paracentesis with the introduction of a blunt instrument through the corneal incision and gently triturating the lens. In some instances this procedure was accompanied by iridectomy, a la Foerster. Although this operation had many advocates, it has ever had many harsh critics, among them De Wecker, who termed it the "still-born operation," and, indeed, it seems fraught with danger. Except in the hands of the most skilled, there is liability of damage in many ways. A little too

[1] Archiv. f. Ophthal., x, a. 2, S. 209.
[2] Foerster, Archiv. f. Augenheilk., xii,3, 1881.

much pressure on the spatula during massage will produce luxation of the lens. A delicate brittle capsule may be ruptured and followed by rapid swelling of the lens and secondary glaucoma. Unavoidable injury to the iris may produce extensive adhesions or even iridocyclitis. Moren reports one case followed by abscess of the cornea and another by iridocyclitis and insidious phthisis bulbi. It is generally conceded that it is contraindicated in atheromatous subjects, because of consecutive glaucoma, and in cataracts accompanied by choroidal lesions. After some ten or twelve years of experimenting and discussing, the cause of artificial ripening was not advanced. The operation was about as formidable as the subsequent extraction, yet the perplexities of the latter were in no way lightened by it. On the contrary, it was by many thought to increase its difficulties.

III. **Intracapsular Injection.**—MacKeoun,[1] basing the idea on an observation of Sir Wm. Bowman to the effect that, when the crystalline, in its capsule, was put in a vessel of water, by osmosis, a separation occurred between the lens substance and the envelope, conceived the notion of maturing cataracts by injecting a few drops of water by means of a Pravaz syringe. More recently, 1899, Jocqs, of Paris, proposed the same measure, only substituting for the water a small quantity of the aqueous humor of the eye concerned, which he injected by means of special apparatus devised for this purpose. Whether or not Jocqs ever tried the method on the human being, I do not know. He believed that the capsule was not left open, but through some experiments instituted by Mellinger, of Basle, it has been demonstrated that cataracts thus produced are only traumatic ones with laceration of the capsule. Spataro experimented on the eyes of 23 rabbits with Jocqs' method and produced 17 cases of severe iritis and 2 cases of glaucoma. He also proved, by control animals, that the injection of aqueous humor was much more provocative of unpleasant reaction than was that of distilled water or of normal salt solution.

IV. Since the observation of Wathen, in 1885, to the effect that exposure of the eye to high degrees of heat, cataract often followed, a number of similar reports have occurred in ophthalmic literature. Meyhofer, for example, found among 506 glass-blowers 59 cataract patients, 42 of whom were under 40 years of age. And

[1] Ophth. Society of Great Britain and Ireland, 1885.

out of 30 workers in a glass factory, Hirshberg discovered 5 who, in their 40th year had cataracts. Arlt records like experiences. Hess declared, from experiment, that high degrees of heat destroyed the epithelium lining the anterior capsule, and thus interfered with the nutrition of the anterior lens fibres, resulting in cataract. With the knowledge of these facts, Wolfberg (Die Ophth. Klinik. No, 52, 1904) conceived the idea of opacifying the lens by means of a hot-air douche. For the purpose he invented an apparatus which he calls a "Kalo-visator," by which a stream of air, heated to form 70 to 100° C., is passed from a spirit lamp, through an asbestos tube, whose mouth is held close to the closed lids. He estimated that the temperature of the air that reaches the eye varies between 70 and 80° C. The applications are made for five minutes, two or three times a day, for eight successive days. This usually insures the desired ripening. He uses it after discission in high myopia, and after iridectomy in senile cataract.

Bahr, of Mannheim, at the Congress of Lucerne, in 1904, advocated the making of a paracentesis in immature cataracts, accompanied by direct massage of the lens with a spoon or a spatula, as others before had done, but with the difference that he recommended a somewhat forcible massage, lasting two minutes, and that the extraction should follow after only five days. He declared that not only did the lens shell out of its capsule more readily after this procedure than after natural maturation, but that, owing to the new vessels at the site of the incision consequent upon the first operation, healing was more prompt. It cannot be denied, however, that such rubbing of the lens at the hands of any but the most skillful, would often lead to dislocation and loss of vitreous and other complications in the extraction.

Artificial ripening is now deemed inexpedient by the great majority of ophthalmic surgeons, excepting in a very small proportion of well-selected cases. When it is resorted to, the method usually chosen is that of Foerster, viz., iridectomy and massage through the cornea with the back of a Graefe hard-rubber spoon.

HISTORICAL.

Although it has been variously hinted and asserted that cataractous lenses were removed bodily from the human eye by the

ancient surgeons and those of the Middle Ages, yet prior to the last decade of the 17th century, all that was said in this connection seems to have rested on mere assumption. In fact, previous to the period just alluded to, it was not known that cataract had aught to do with the crystalline, but was thought to be a sort of pellicle or film situated in front of that body. The discovery that cataract consisted in opacity of the lens, was made by the French surgeon-oculist, Antoine Maitre-Jean, in the year 1691. He examined, *postmortem*, the eyes of a woman in whose case, five weeks before her death, he had made depression in both eyes, and there he found the opaque lenses lying behind the lower portions of the irides. It was not, however, until 1705, after a memorial presented to the Paris Academy of Sciences by the younger Brisseau, that the truth as to their identity became generally known.

It is recorded that Blancard, of Amsterdam, had, in the last decade of the 17th century, proposed the extraction of cataract, and that Johann Conrad Freytag, of Zurich, had, between 1692 and 1698, actually undertaken to remove portions of a dislocated lens from the anterior chamber through a corneal incision.

The first authentic record of a cataract extraction from a living subject was that of Charles de Saint-Yves, surgeon to the Hospital of St. Lazare, at Paris, in 1707. It was of a lens that, after having been depressed, found its way into the anterior chamber, and the operation was undertaken for the relief of pain, the eye having been sightless. One year later, St. Yves and another surgeon, François Pourfour du Petit, extracted a similarly dislocated lens which, two years before, had been couched. This last case not only served to add proof to the idea that cataract was not a veil in front of, but cloudiness within, the lens itself, but also to demonstrate the true function of the crystalline; for, with the aid of a strong convex glass, the patient was able to read with the operated eye. The presence of the lens within the eye had always been considered absolutely essential to sight.

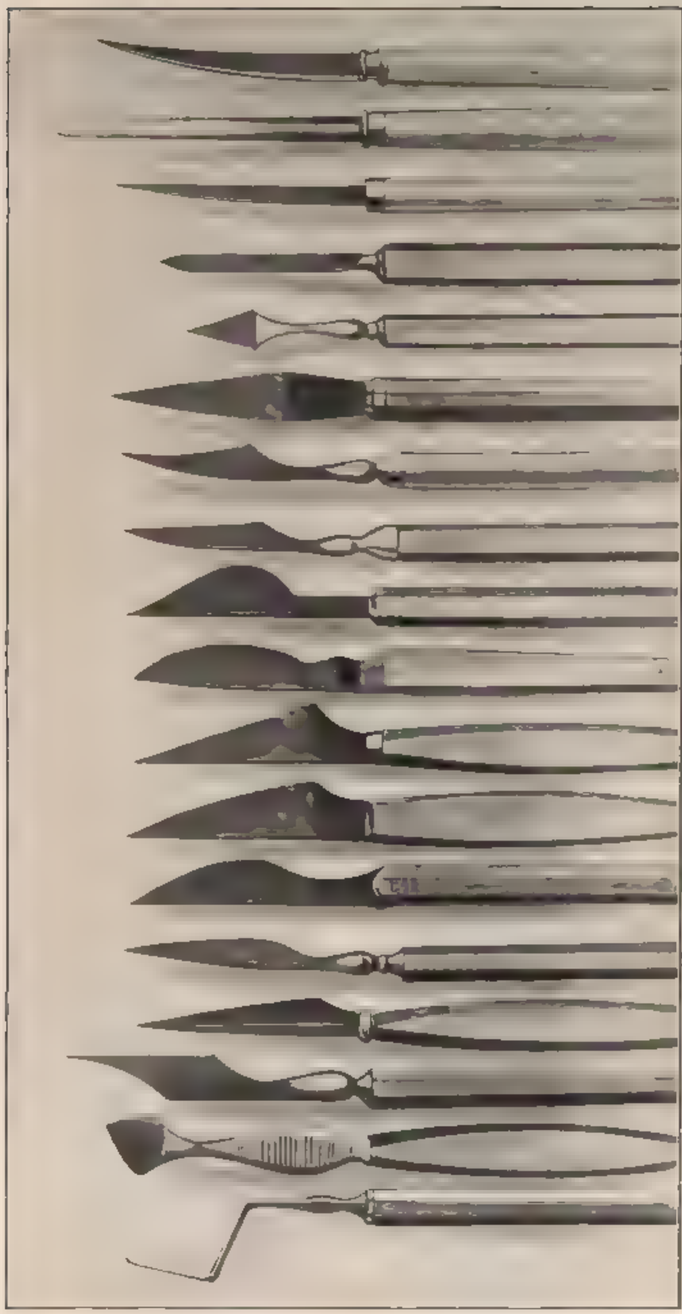
Méry, who assisted in the operations of St. Yves and Petit ,was the first to conceive and propose the idea of extracting, through a corneal incision, a cataract from behind the pupil.

These were some of the forerunners of the operation for the extraction of the lens from its normal site, as first practiced,—also by

DESCRIPTION OF PLATE IX.

1. De la Faye, 1752, curved on the flat.
2. Poyet, 1753.
3. Tenon, 1757.
4. Von Graefe, 1855.
5. Daviel, 1750.
6. DeWenzel, 1762.
7. Samuel Sharp, 1753.
8. Warner, 1754.
9. Béranger, 1757.
10. Pamard, 1759.
11. Barth, 1795.
12. Beer, 1800.
13. Richter, 1770.
14. Young, 1756.
15. Jaeger, 1873, right and left.
16. Inouye, 1900.
17. Weber, 1867.
18. Taylor, 1900, right and left.

PLATE IX.



a Frenchman, the immortal Jean Jacques Daviel—toward the end of the year 1747. It was while making unsuccessful efforts to couch a cataract that it occurred to him to open the lower portion of the cornea and remove the obdurate crystalline, which he immediately proceeded to do, and with most gratifying results. The eye recovered promptly and retained good vision. Like a number of his predecessors, Daviel had already extracted fragments of cataracts that had wandered into the anterior chamber after depression,[1] and his experience in this line, added to the success of the extraction just related, incited him to further attempts in the same direction, and from that time he began the systematic extraction of cataracts. He was aware of the shortcomings of the older operation and he pinned his faith to the possibilities of the new one.

In 1750, he was called to Mannheim to operate on a member of the royal family, and while there made three extractions, the details of which he narrated in a letter to a friend in Paris, which constitutes the first description of his methods. By the time he contributed his notable memoir on the subject to the Paris Royal Academy of Surgery (Nov., 1752), he had made 206 extractions, with satisfactory results in 182 instances.

Daviel's Manner of Operating and the Instruments he Used.—Patient and operator sat in chairs facing each other. He began his corneal incision near the lower limbus by inserting there a small lance-shaped knife, or broad two-edged needle, with curved shank. The small cut thus made he extended in either direction by means of a similar but smaller and blunt-pointed instrument. If obliteration of the anterior chamber and flabbiness of the cornea interfered with this mode of extension, he substituted small scissors. Of these there were two pairs, one curved on the flat and to the right, with the right blade blunted, and the other curved on the flat and to the left, with the left blade blunted—for the corresponding sides. With these he carried the incision around parallel with the limbus in each direction to a point a little above the pupil, which means that it included quite a little more than one-half of the cornea (Fig. 248). He afterward limited the extent to one-half the circumference (see cut). He lifted this large flap with a gold or silver

[1] Daviel's first case of this kind was in the year 1745, and the subject was the hermet of Aiguille, in Province. The eye was lost by suppuration.

spatula, and incised the anterior capsule with a small curved, two-edged needle, loosened the cataract further, if need be, with the spatula, and delivered by external pressure upon the lower lid. Broken masses of the lens were laded out with a tiny elongated gold or silver scoop, the same that is in use by many for other purposes and by a few for the same to this day. If the iris got into the incision, it was returned to the anterior chamber by manipulation of the spatula and, occasionally, after unusual wounding of the iris, the injured portion was excised.

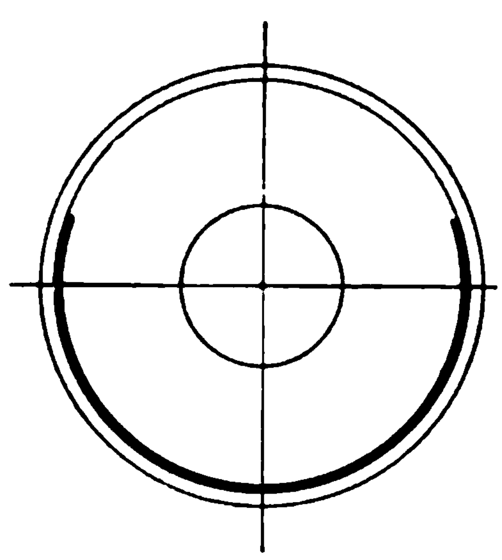


FIG. 248.—Daviel, 1750.

It will be seen from the foregoing, therefore, that, notwithstanding the lapse of 160 years, the best efforts of all of his successors and the many modifications and changes that have been suggested, aside from the relatively slight variations in technic, Daviel's operation was not essentially different from the most approved at the present time.

Let us note some of the phases through which the corneal section has passed and some of the forms and alterations that have characterized the cataract knife.

Changes in the Incision.—When one contemplates how important is the rôle played by the primary section or opening of the globe, its position, form, and extent, in the operation of extraction, it is truly remarkable how near it still is in these respects to Daviel's conception. True, he made the corneal flap downward (excepting that for a short time, while in his last days, he experimented with a new triangular, or *ogival* flap, which he tried outward and also upward as well as downward) as did all of his successors, with but few exceptions, for more than a century. In 1784, Pièrre Pamard, of Avignon, made an upward section. This surgeon had adopted Daviel's operation as early as 1758, and had striven earnestly to improve it. He broke away from tradition sufficiently to operate his patient lying. He used a lance-shaped knife of his own invention, as also a sharp hook with which to steady the eyeball. The elder Baron de Wenzel, in 1766, using his broad double-edge knife, made an upward and outward flap, and his son, Michel Jean Baptiste de Wenzel, about 1800, was one of the pioneers of the upward method.

In Germany, among the first enthusiastic advocates and modifiers of Daviels's operation, was August Gottlob Richter, the justly celebrated surgeon of Göttingen, whose labors extended over some twenty years, or from about 1770 to 1790. He, too, made downward section, including one-half the cornea, with a knife like that of Béranger, of Bordeau, save that for a short distance it was double-edged (Fig. 249).

The work of Richter was carried on by Barth, of Vienna, and by his successor, the great Beer, the teacher of Graefe, Langenbeck, and the elder Jaeger. To the latter he became also father-in-law. Barth is said to have devised, in 1795, the triangular cataract knife commonly accredited to Beer. Barth changed the edge of the

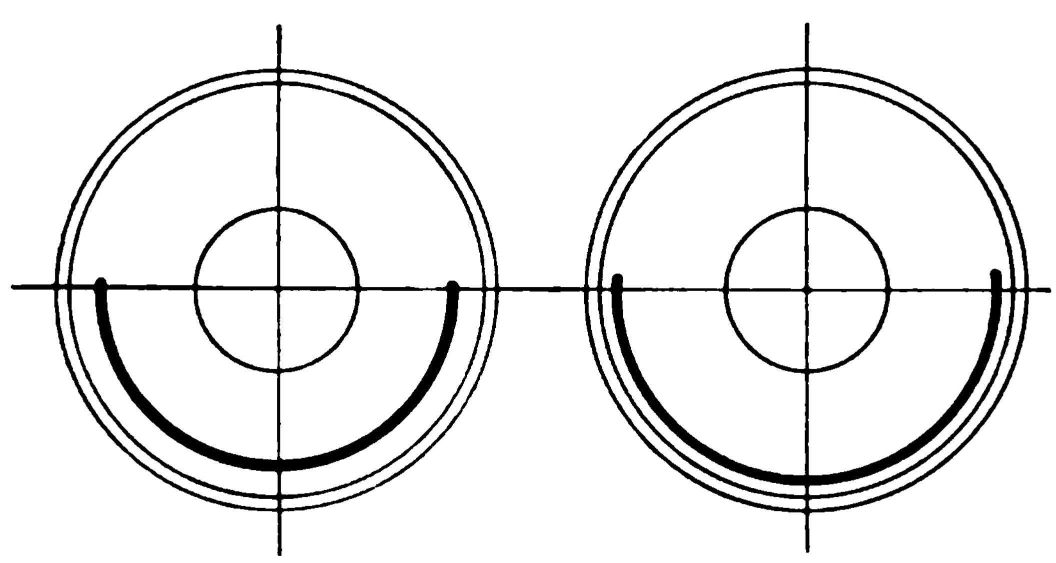


FIG. 249.—Richter, 1780. FIG. 250.—Barth & Beer, 1795.

Béranger knife from convex to straight, claiming for the latter form better cutting qualities and, like Daviel and Richter, made a downward flap, including half the corneal base (Fig. 250). It may be mentioned that almost all of the operators, from Daviel down to the time of Beer—yes, even to the time of Desmarres—extracted without the use of either lid speculum or fixation appliance, which fact speaks well for their prudence as well as for their dexterity. Richter and Beer, operating, respectively, in Germany and Austria, so improved the instruments—in short, so advanced the status of the operation—that their methods have been termed *classic;* and, as a further tribute, their additions to the measure were adopted in the home of Daviel by the two greatest living ophthalmic surgeons, Sichel and Desmarres. (For other reference to Richter and Beer, see section on Extraction of the Lens in its Capsule.)

Another school of surgeons, beginning with Palucci, in 1752

(Fig. 251), and later, Santerelli, in 1795, sought to renew the linear extraction, though their efforts were not strongly seconded (Fig. 252). This was the form as instituted by Saint-Yves and Petit, the fathers of extraction, and, as if to mark the centenary of their discovery, a revival of linear extraction was inaugurated by Gibson, of London, in 1811, and by Friederick Jaeger, of Vienna, in 1812. Indeed, it was the latter who gave the operation the designation, *linear.*

This movement had its culmination in Great Britain, having been given great impetus by Travers (1814) and Burton, of London (about 1820). The former was especially instrumental in forwarding it, and the fruits of his activity are visible in the latest phase of the operation. He strove for a minimum incision, and for a

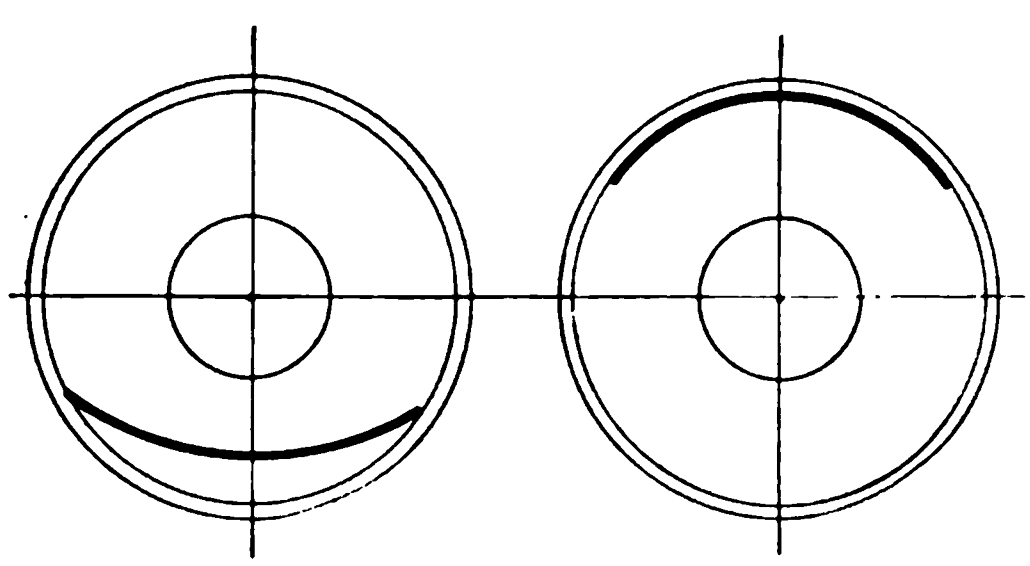


FIG. 251.– Pelluci, 1752. FIG. 252.—Santerelli, 1795.

method free from loss of vitreous and iris complications, also for one less difficult in the making, seeing that with such an incision, blepharostat and fixation forceps could be used with more confidence. He first limited his form of extraction to soft cataracts. With a reclination needle, he dislocated the lens into the anterior chamber, then extracted it through a small linear corneal incision. Traver's wound was made above and included just 1/4 of the corneal margin, hence it became known as Traver's *Quarter Section* (Fig. 253). Later he applied this kind to extraction in general, not limiting it to certain soft cataracts, and those that had been previously broken up as by discission, using a sort of thin spoon to deliver the lens. In after years Sir William Bowman and the elder Critchett, of London (1864), reverted to the Travers' operation, though they extended, with scissors, the incision begun with the keratome, so as to include 1/3 or more of the corneal base, added an iridectomy, and

employed a thin, broad, curved spoon or spatula as the traction instrument (*scoop extraction*).

In the meantime, Albrecht v. Graefe, of Berlin, had begun his brilliant though brief career. After Daviel, he who made the most profound impression upon the principles and the art not only of the surgery of cataract, but upon the science of ophthalmology as a whole, was von Graefe. At the early age of thirty he had sounded the depths and the shallows of the two methods of linear and flap extraction. He recognized their respective failings and advantages. From the suppurations and lack of coaptation of the flap extraction, he sought refuge (1853) in the more prompt healing of the linear incision placed in the sclera; and from the iris, capsule, and cortex

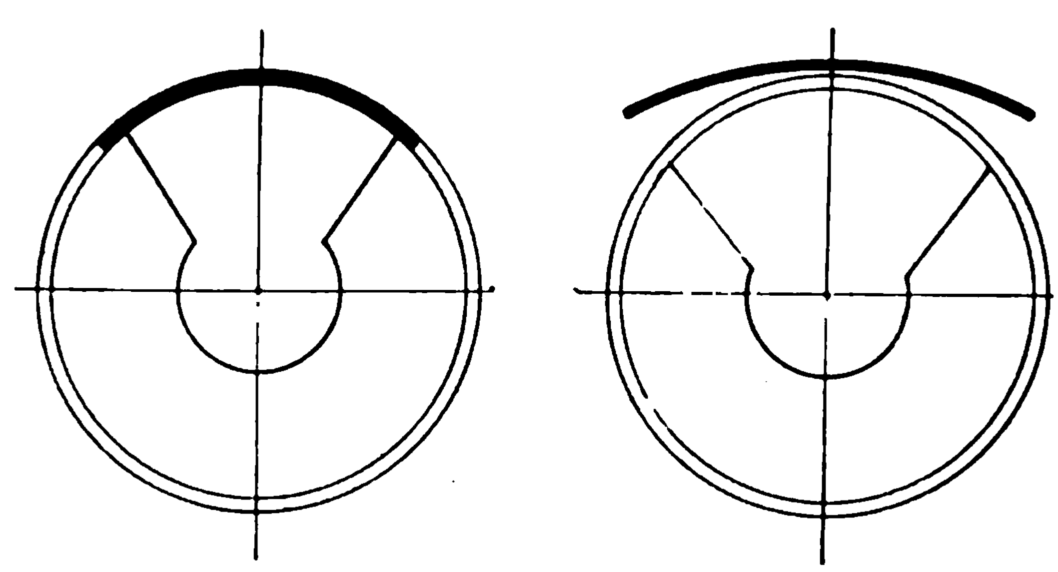


FIG. 253.—Travers, 1812. FIG. 254.—Von Graefe, 1859.

complications, in the removal of the contiguous portion of the iris, as first definitely recommended, as a part of the operation, by Schifferli, of Jena, in 1776. In this he reverted to the operation of Travers, making a small incision in the upper limbus, adding iridectomy, and delivering the lens by means of the clumsy spoons devised by his assistant, Waldau. He confined the operation to the softer forms of cataract or to those with soft cortex and small hard nucleus. But for the sclerosed, more voluminous senile cataracts he still made the flap extraction. Little by little he raised and extended the incision of Travers, until it approached more nearly to the linear, in effect, until it was finally placed wholly in scleral tissue, substituting for the lance-knife his straight narrow *Schmalmesser* (1859). (Fig. 254).

Although Daviel never relinquished his early manner of making the section, i.e., beginning with his small lance-knife and enlarging

with knife and scissors, his friend and colleague, George de la Faye, as early as 1752, suggested a narrow bistoury, curved on the flat, for making the entire flap at one cut (Plate IX, No. 1). This one-instrument idea was put into execution, about a year later, by Samuel Sharp, of London, though with a triangular knife of his own design (Plate IX, No. 7). There were thus, in the very beginning, the three leading models of the corneal knife, viz., Daviel's, De la Faye's, and Sharp's. These are the precursors, of which all that have since been devised are but modifications.

Daviel's (Plate IX, No. 5) was the parent of the trowel form (de Wenzel's, Weber's, etc.) of which the modern representative is the lance-keratome. Sharp's found its counterparts in the various half-dart forms (Béranger's, Pamard's, Himly's, and Jaeger's) whose latest survivor is the Beer's knife; while De la Faye's was the progenitor of the narrow, straight type now in general use, coming down through that of Poyet, Tenon, and v. Graefe.

It must be remembered that the true Graefe Schmalmesser was of decidedly different pattern from that which still bears the name, and is the almost universally accepted form. A glance at Plate IX. No. 4 will at once make the difference apparent. The original Graefe blade was longer and broader, the edge and back were perfectly parallel up to within some three or four millimeters of the end, whence the blade was two-edged to the point, i.e., the tapering portion was two-edged.

It is now more than fifty years since v. Graefe devised his so-called modified linear incision, though, to speak technically, it was not what its name implies, but a high or scleral and conjunctival flap of low arc. It began on either side, one and one-half to two millimeters behind the sclero-corneal junction, and was carried upward and forward, with a slight curve, and ended with a small conjunctival flap, barely posterior to the junction. In conjunction he made a very broad and very peripheral iridectomy. Graefe succeeded thus in making a perfectly coapting and quickly healing incision which greatly reduced the frequency of infection, but at the expense of other disasters which more than offset its advantages.

Among these, on account of the proximity of the cut to the zonule and the ciliary body, were a large proportion of vitreous losses (about one in seven), and because of the tremendously peripheric

iridectomy—deep uveitis, with punctate keratitis, and almost constantly recurring entanglements of the iris and shreds of capsule in the angles of the incision, leading to drawing upward of the iris, to dense secondary cataract, and to closure of the pupil. Moreover, it was but natural that in addition, and as sequels to these mishaps, the still greater terrors, glaucoma and sympathetic ophthalmia, became more obtrusive.

De Wecker[1] says: "Personne ne pourra nier que les ophthalmies sympathiques, presque inconnues au temps de Daviel, Wenzel, Beer, Sichel et Desmarres, n'aient fait leur triste apparition que depuis, d'après Jacobson et de Graefe, on a poussé davantage la section vers la région scléroticale, et qu'on s'est rapproché plus en plus de l'angle iridien, mis en outre à deconvert par l'excision de l'iris, généralisée comme méthode operatoire."

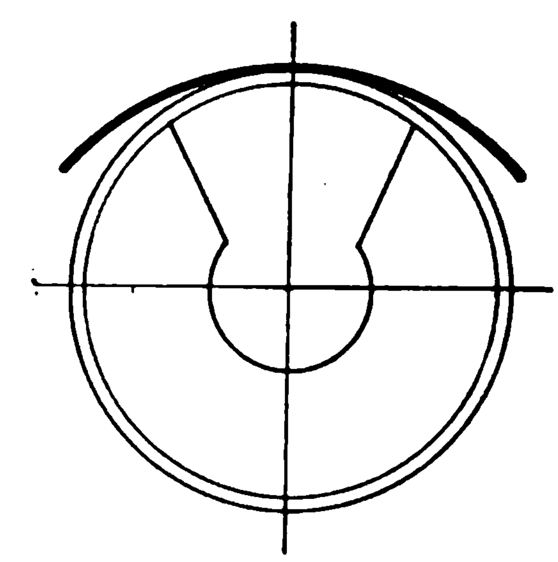


FIG. 255.—Von Graefe, 1867.

For these reasons this master was soon constrained to alter his course. As Panas[2] expresses it, "De Graefe with his well-known sincerity in matters scientific, was the first to indicate the weak points of his method." Consequently he brought his incision further forward, approaching more nearly the small corneal flap, and reduced the size of his iridectomy (Fig. 255). Having heard much of the brilliant results achieved by Bowman and Critchett, with their scoop extraction, and, to again quote Panas, "Desirous of observing their work, in the fall of 1864, he made a trip to London, and on his return to Berlin, he made 118 extractions after the *English mode*. Among the number, he had 11 total failures by panophthalmitis or consecutive cyclitis, 28 occlusions of the pupil, that necessitated ultimate intervention, and 11 abundant losses of vitreous; not to mention the fact that, in many cases, the ejection of the lens remains was laborious and often incomplete."

So, with indomitable perseverance, he strove, till, by his modified flap operation and the accession of the compressive bandage—about 1864—he was at last able to announce that in 900 consecutive

[1] Traité conplet d' Opht. de Weckerand Landolt, vol. ii, p. 1016.
[2] Panas, Maladies des Yeux, vol. i, p. 576.

extractions he had a loss by panophthalmitis of but 5%. About this time, Graefe's colleague, Jacobson, came to the front with his conception of the flap extraction. This consisted in a downward section, situated one-half millimeter behind the conjunctival limbus or in the opaque cornea, and included just one-half of the corneal base (Fig. 256), and was combined with an enormous iridectomy. Through the efforts of these two surgeons, ere the dawn of antisepsis, the occurrence of suppuration, after cataract extraction, was reduced to at least one-half what it had formerly been

Following close upon Graefe, Jacobson, Bowman, and Critchett came De Wecker, of Paris, about 1869, offering his combined operation. Its feature was an upward corneal flap, two to three milli-

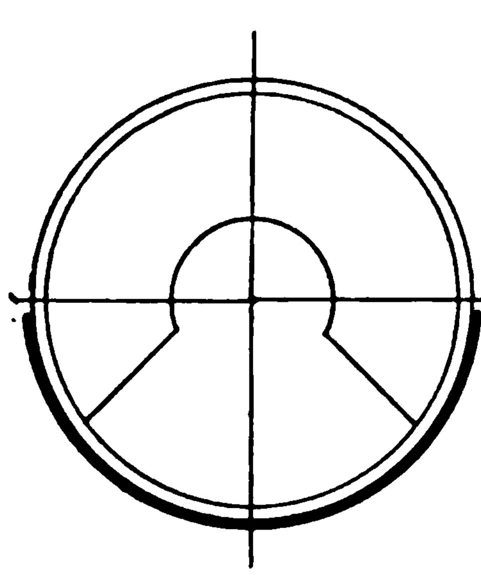


FIG. 256.
Jacobson, 1864.

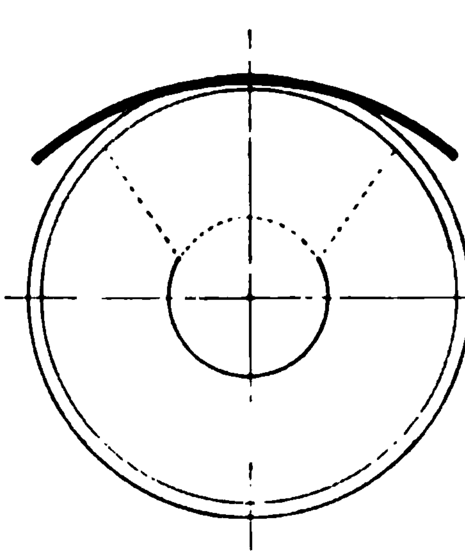


FIG. 257.
De Wecker, 1869.

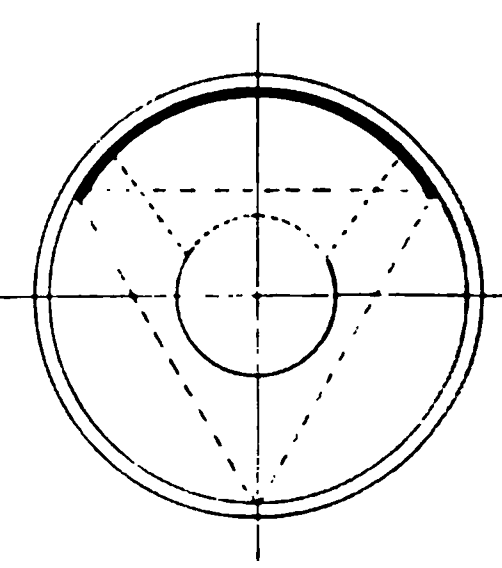


FIG. 258.
De Wecker, 1875.

meters high, made by an incision beginning in the sclera, on either side, and ending in the limbus, thus having scleral ends—"*Extraction combinée a petit lambeau.*" The length of De Wecker's incision was 11 millimeters, whereas v. Graefe's linear was 10 millimeters (see Fig. 257). This he afterward (1875) altered to his two millimeters high, purely corneal flap, exactly in the upper limbus, and including just 1/3 of the corneal circumference "detachment of the superior third of the cornea"—and, *most important*, returning to the method of Daviel in that he omitted the iridectomy—"*Extraction simple a petit lambeau*" (Fig. 258).

For the fashioning of his section De Wecker used a knife modeled after that of v. Graefe, though hardly more than half the width, and gradually increasing in thickness, at the back, from point to heel, until at the shank it was one millimeter through. Something the

shape of a three-cornered steel file. While this particular pattern has not been perpetuated, it undoubtedly was the forerunner of the changes that have culminated in the type in general use at the present momnet. (For description of said type, see chapter on the Management of Instruments.)

Thus, after wandering up and down the world for more than a century and a quarter, undergoing many vicissitudes, alternately nourished, starved, and forsaken, do we see the operation of extraction enter into its rightful heritage in the land of its birth. For it was the notable contribution of De Wecker[1] in 1875, to the Paris Academy of Sciences, that sounded the knell of abaissement and reclination, and antisepsis gave the *coup de grace*. Previous to this there had never been a time when the latter procedures were not extensively practised and that, too, by the shining lights of ophthalmology. Over and over again would they drop extraction to take up the primitive method.

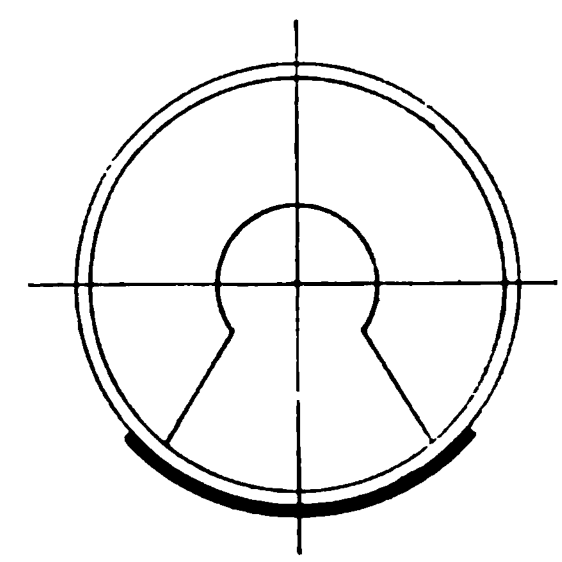


Fig. 259.—Weber, 1867.

To conclude this history, already too lengthy, here follows brief mention of a few other modes of making the keratotomy that were devised in the scant years prior to De Wecker's paper.

About the year 1867, Adolph Weber,[2] of Darmstadt, had constructed, for making the linear incision, a broad lance-knife, something after the model of the old Santerelli knife of 1795. It differed from the modern wide iridectomy knife only in having a blade concavo-convex, in the transverse sense, with the convexity directed upward (Plate IX, No. 17). It was designed to make an incision similar to Graefe's modified linear, only less peripheral and *downward* (Fig. 259). It was probably deserving of a longer life.

Kuchler's Incision.[3]—About the same time that Weber invented his knife, his colleague and fellow townsman, Küchler, conceived the idea of applying to extraction an incision he had, in 1853,

[1] Wecker, Comptes Rendus de l'Acadamie des Sciences, T. lxxx, p. 1294.
[2] Arch. f. Ophthal., xiii, p. 187.
[3] Küchler. Ueber die Querextraktion des Staars Memorabilien, xii, 1, 1867, and die Querextraktion des grauen Staars der Erwachsenen, Erlangen, V. 8, p. 37, 1868.

designed and employed in operating for anterior staphyloma. It was nothing more nor less than an actual transverse section of the cornea, lying exactly in the horizontal meridian, and extending from base to base (Fig. 260). And, by the way, this was the ***only true linear cut*** that was ever made for such a purpose. Küchler called it *Querextraktion.* Although a very poor surgical measure, its name serves to perpetrate a passable English pun.

Liebreich's[1] Incision.—This was a modification of the v. Graefe linear incision, made downward, and with the narrow knife (Fig. 261). Puncture and counterpuncture were made about two

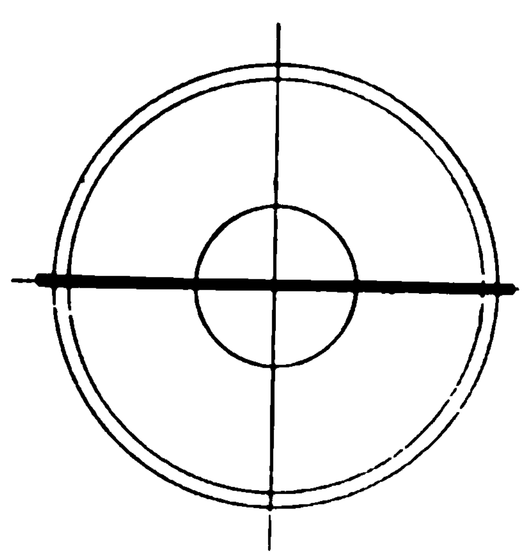


FIG. 260.
Küchler, 1868.

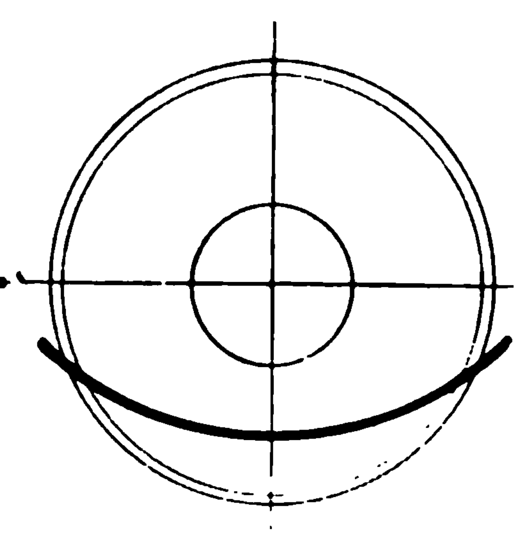


FIG. 261.
Liebreich, 1872.

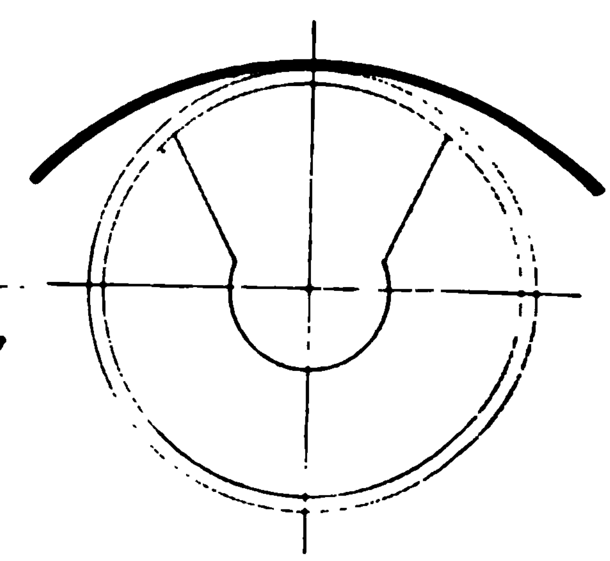


FIG. 262.
Ed. Jaeger, 1873.

millimeters below the horizontal meridian and one millimeter back of the corneal base. The edge was directed downward and forward, cutting in a gentle curve, and coming out two or three millimeters above the lower limbus. The iridectomy was omitted.

Jaeger's[2] Incision.—Edward Jaeger, of Vienna, with the idea of accomplishing the Graefe peripheral linear incision by a single forward cutting movement, as his grandfather, Beer, made the Daviel large flap, constructed a pair of knives, or as he called them, ***Hohl-messers***, one for the right eye and the other for the left (Plate IX, No. 15). If flattened out, their blades would have been like the Beer knife only longer and narrower. Instead of being flat, however, they were concavo-convex in their sagittal planes; and, in order to conform to the curve of the Graefe incision, they were introduced with the concavity forward (see Fig. 262). They proved to be

[1] Liebreich. Eine neue Methode der Cataract Operation, Berlin, 1872. Also Saint Thomas Hospital Reports, vol. ii, p. 259.
[2] Der Hohlschnitt. Vienna V. 80, p. 23, 1873.

more ingenious than practicable. His incision was similar to v. Graefe's, but longer by three millimeters.

Lebrun's[1] Incision.—Under the name, "Extraction with a small median flap," Lebrun, of Brussells, contrived a purely corneal incision. With a medium-sized Graefe knife, edge directed upward and slightly forward, he made puncture and counterpuncture slightly below the horizontal meridian, exactly in the limbus. The cut extended up, with a light forward curve, and ended at the junction of the upper with the middle third of the vertical meridian of the cornea, or about on a level with the upper border of the average pupil (Fig. 263). Warlomont called this the *Belgian Method.* De

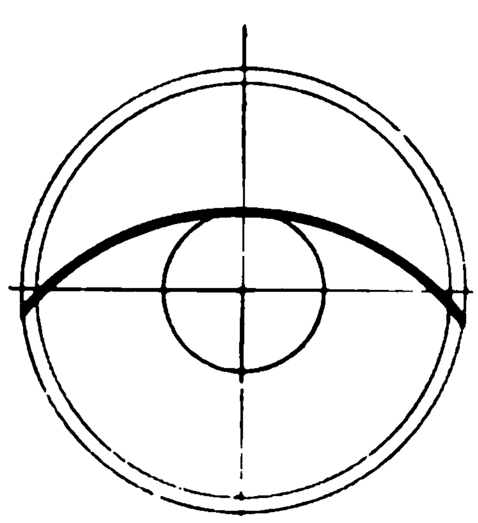


FIG. 263.—Lebrun, 1872.

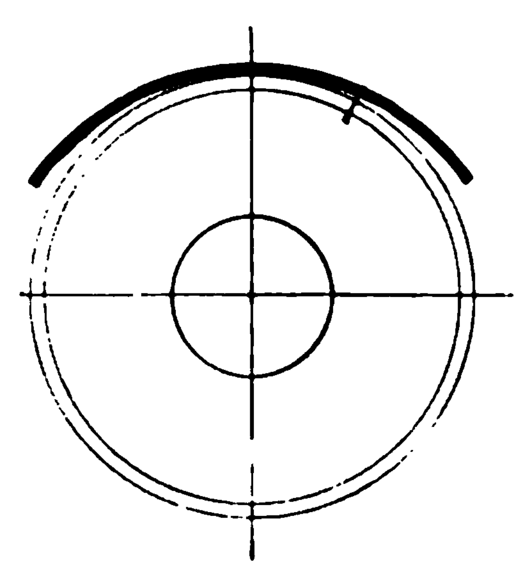


FIG. 264.—Von Arlt, 1874.

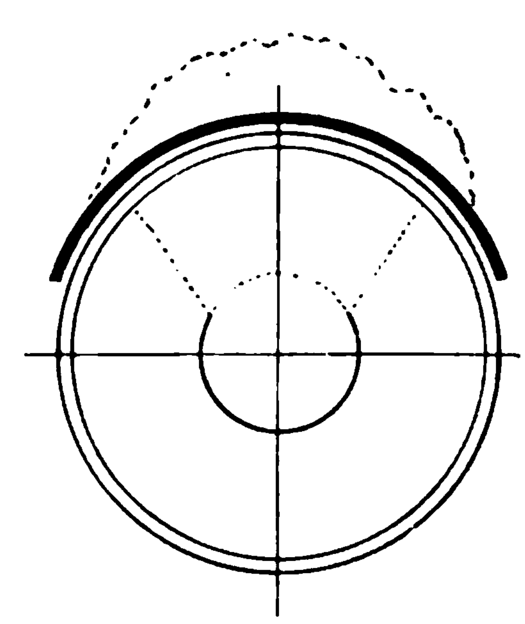


FIG. 265.—Horner, 1884. In scleral tissue.

Wecker added that, in point of prudence, it might better be termed the *neuter method.*

The graver faults of these sections, lying well within the transparent cornea, are want of coaptation, contact with the pupillary border of the iris while the anterior chamber is empty, causing the iris to become entangled, slow healing, from being far from the blood supply (liability to infection), and high degrees of astigmatism in cicatrization. One of the very complications that it was the aim of such sections to obviate was, if anything, yet more frequent, viz., picking up of the iris by the incision. This fact helped to disprove the old rule that *the nearer the incision to the sclera, the more urgent an iridectomy.*

[1] Lebrun. Méthode de'extraction de la cataracte par un procédé a lambeau médian spiro-cylindrique. Trans. London Internat. Congress, p. 216, 1873.

THE MODERN CORNEAL INCISION.

"L'operation de la cataracte, c'est la section."—*Terrien.*

In view of the foregoing considerations, relative to the various forms of the primary incision for the extraction of cataract, it would seem a fitting close to the subject to define just what constitutes a proper section; for it is on this that, in great measure, we rely for success in the operation. What is its particular configuration, extent, and position as most approved at the present time? We have noted some of the faults of the highly peripheral or scleral sections (p. 584) and of those that lie far in the opposite direction (p. 589). It may be stated, then, that an intermediate position is desirable; and the one chosen is precisely at the junction of the cornea and the conjunctiva, the direction of the flap being upward —*superior keratotomy*—and ending with or without a conjunctival flap; the whole section lying in a plane parallel with that of the base of the cornea (Fig. 266).

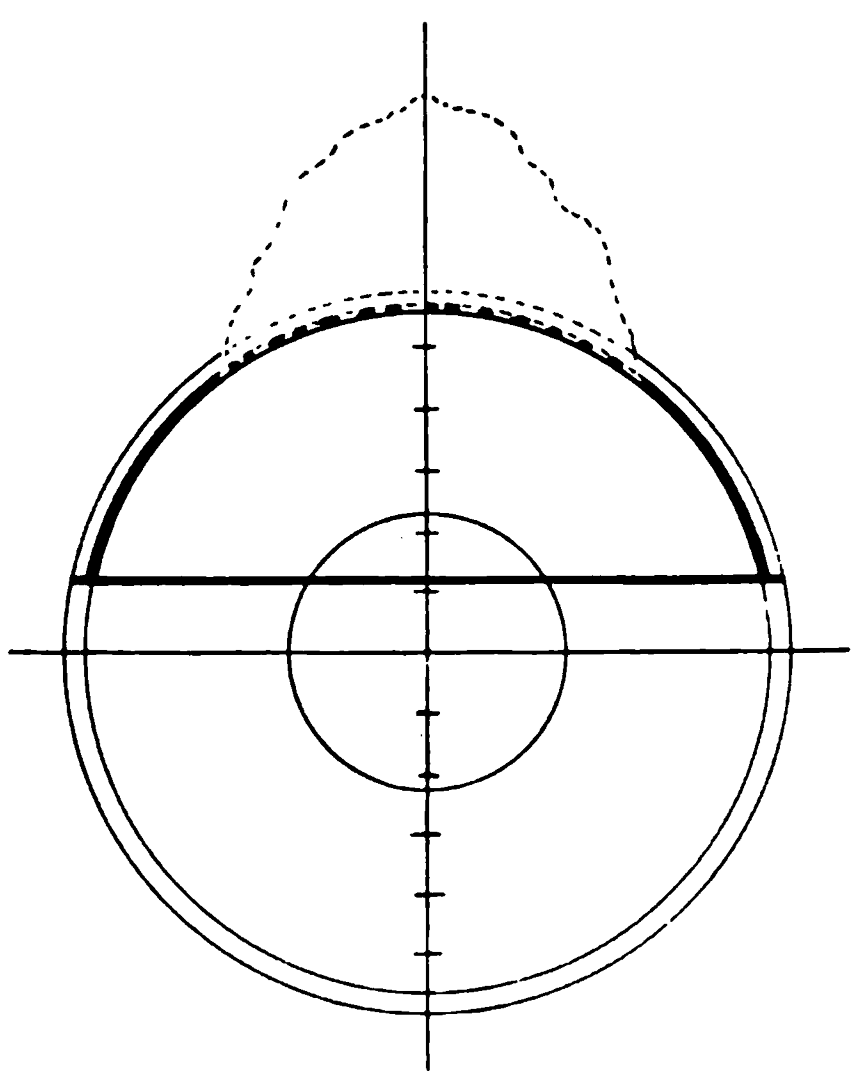


FIG. 266.- Modern incision for cataract.

As regards the proper extent of the incision, or, in other words, its length as measured around the corneal base, there have been no definite limits fixed, nor is it practicable to do so, except approximately. There must be some latitude in the matter. We have seen how very objectionable is a wound too small, yet, how seemingly little it matters if it be larger than necessary. Therefore, knowing the uncertainties of the act, one may so begin his section as to favor the chances of erring on the safe side, i.e., of needless length. The supposed size of the cataract, for example, or the particular difficulties that are apprehended in a given case, of necessity, influence the operator's judgment in selecting the points of puncture and counterpuncture. Manifestly, these two points mark

the lower bounds of the incision, and are supposed to be on the same horizontal level. Assuming that these terminals can be accurately placed as desired—which at the hands of the experienced operator is pretty certain—and that the cut will unerringly follow the limbus from start to finish, one might with tolerable certainty give a uniform configuration, position, and extent. Now, such infallibility is not possible to the skillful, even in operating on pig's eyes in a mask, much less so, to all degrees of dexterity, in dealing with the living human eye, in subjects possessed of all grades of sense and sensitiveness.

Hence, the making of a uniformly satisfactory corneal section is, perhaps, the most difficult feat in all surgery—a feat to which the greatest has never attained. Agnew, with all the marvelous precision of his art, and De Wecker, startlingly brilliant as he was, I have seen baffled in their aim in this particular. True, if one were satisfied to habitually make an unduly large section, the thing might be easier.

In order to locate the site of puncture and counterpuncture, it has been customary, with most operators, to select a certain fraction of the corneal circumference that shall be detached: Daviel, 1/2 to 10/16; Travers, 1/4; Critchett and De Wecker, 1/3; Panas, 2/5, etc., the idea being to bisect the extremities of this chosen arc as puncture and counterpuncture. To me, a readier way has always seemed the fancying of a sort of scale marked upon the vertical diameter of of the corneal base, and to choose thereon the level of the two points. In other words, to place the horizontal chord of the arc and not the arc itself. It will be seen by looking at Fig. 267, that Travers' *quarter section* arc included about 1/6 of said diameter; Critchett's and De Wecker's 1/3 arc just 1/4 the diameter, and Stellway v. Carion's and Panas' 2/5 arc about 1/3 of the diameter.

Now, Travers' section is obviously too small for other than instrumental delivery of any ordinary cataract, although it were made in the plane of the greatest corneal curve, viz., the base, and with the curve of both wound openings parallel, which, of course, would mean as near as possible to the true linear section (Fig. 268). Critchett's and De Wecker's, if it could be made ideal, i.e., exactly in the base and with the minimum of difference in the size of outer and inner wound openings, should be adequate for any ordinary senile

cataract. Several things may conspire, however, to make this impossible, as a shallow anterior chamber, an intractable patient, early escape of the aqueous, etc. It may be set down, therefore, that a flap whose height (or breadth) is equal to one-third of the diameter of the

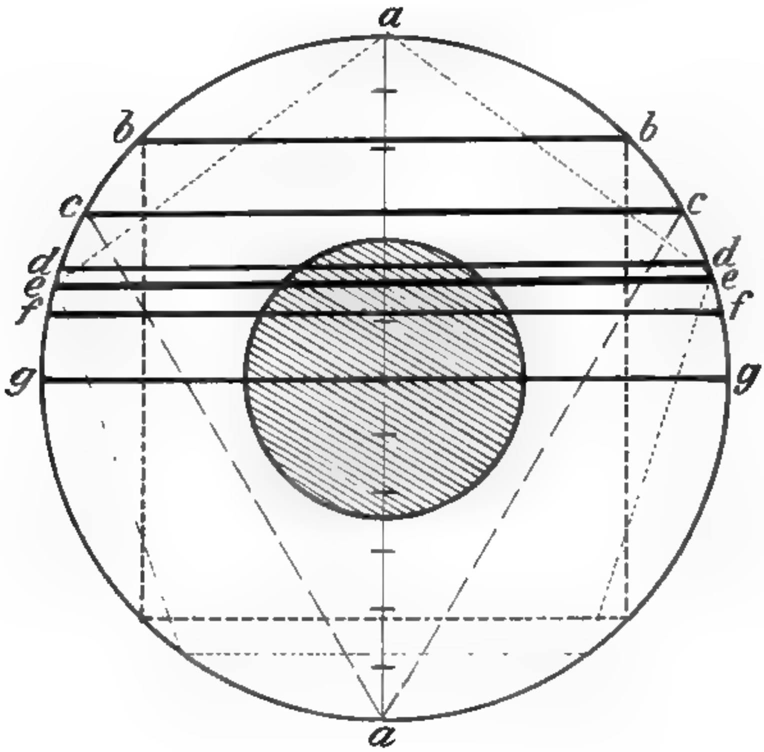


FIG. 267.

a a. Vertical diameter. The divisions represent millimeters.
b b. One-fourth the circumference or a little over one-seventh the diameter
c c. One-third the circumference or one fourth the diameter.
d d. One third the diameter
e e. Two-fifths the circumference } These two fall approximately together
f f. Two-fifths the diameter.
g g. One-half the diameter also one-half the circumference.

corneal base—or about equivalent to two-fifths of the circumference, as recommended by Stellwag and Panas —if made with due regard to the rule of the procedure, will afford an ample opening for the largest lens, and leave margin enough to cover slight irregularities.

What are the rules or principles to be observed in the fashioning

of the flap or of the incision? Aside from those already mentioned as to *position* and *extent*, the most important has reference to the *configuration*, and may be thus concisely stated: *Let there be the leas possible difference between the sizes of the inner and outer wound openings* (the minimum length of "wound-canal," as the Germans call it). How to accomplish this result? The briefest answer to this

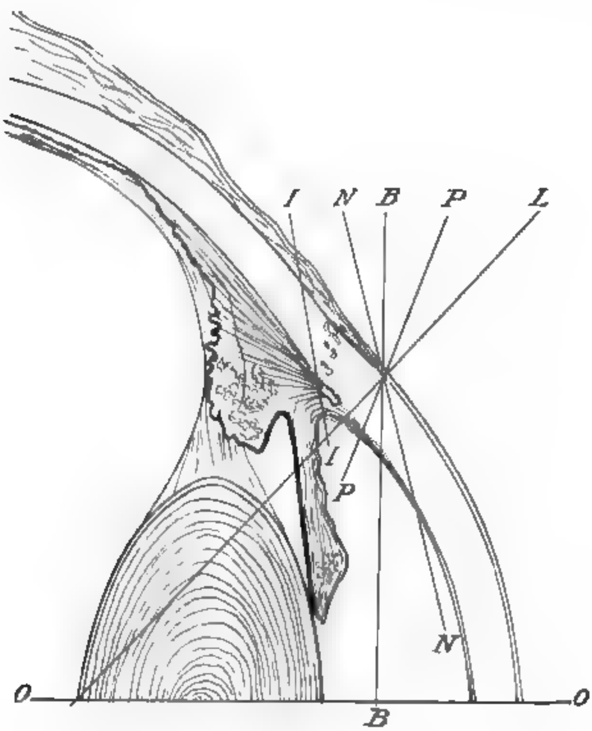


FIG. 268.—*O O* Optic axis. *B B*. Plane of corneal base. *L L*. Linear incision. *P P*. Positive inclination. *N N*. Negative inclination. *I I* Iridectomy incision.

question is, *avoid splitting the cornea*. Make the breadth of the lip of the incision at a given point approximate the thickness of that portion of the cornea (Fig. 269). This is best effected, first, by holding the blade of the knife perpendicular (or nearly so) to the tangent of the corneal curve in making the puncture, then depressing the handle (in the backward sense, or toward the patient's temple), all the while pushing the point of the blade to a point opposite the center of the pupil, and again depressing the handle

(this time in the downward sense, or toward the patient's feet) to make the counterpuncture. This gives the most direct wound angle, in both vertical and horizontal planes, that it is possible to make.

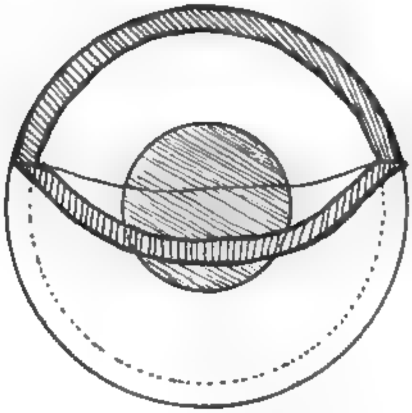


FIG. 269.—Ideal section.

The wound-lips at the counterpuncture can never be so steep as at the puncture (Fig. 270), because they must be made with the blade in the horizontal position. The object here, then, is to keep

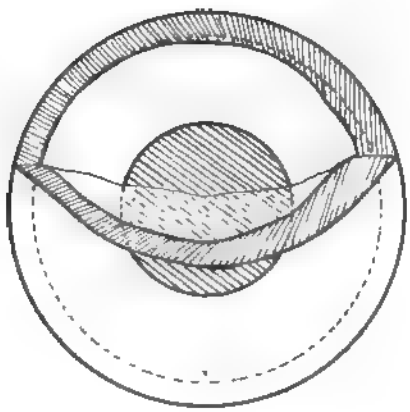


FIG. 270.

the knife down close to the iris so as to go most directly through the cornea. The further back the counterpuncture the larger the opening, or at least, the more nearly in the limbus; but the de-

ceptive refraction which makes the knife appear much nearer than it really is must be borne in mind (see description of operation on p. 488). In this way, although the inner angle of the incision is

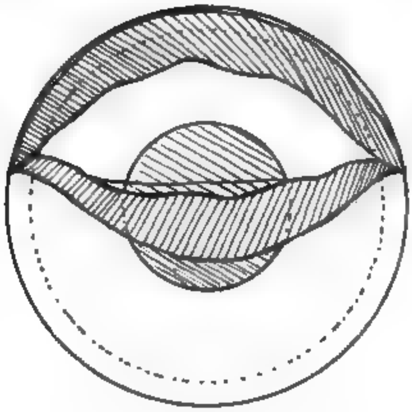


FIG 271.—Split in finishing.

less direct than the outer, not only is an ample opening insured, but there is less risk of making the lips too slanting in the rest of the section (See Fig. 271).

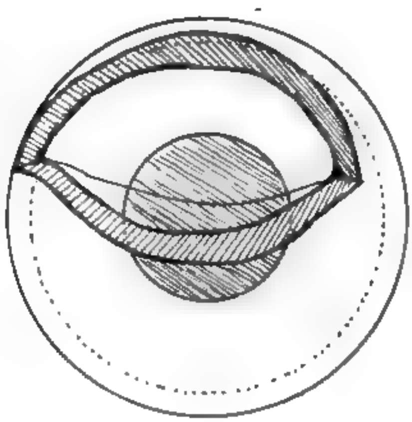


FIG. 272.—Counter-puncture too far forward.

By the time the two punctures are made, cutting upward is already under way, as it were, the knife is held strictly to the limbus, on both sides, and, as the edge disappears in the upper

iridic angle, if a conjunctival flap is desired, it (the edge) is turned backward to emerge beneath the membrane.

I look upon this flap, identified with Desmarres, as one of the keys to the situation, not alone in simple extraction, but in the combined as well. It is not prone to become misplaced, but clings to its original site with singular pertinacity, and heals solidly in a few hours, thus holding the incision closed; and to be held shut favors primary union, absence of iris complications, and many other untoward happenings. It need not be in the way of the subsequent

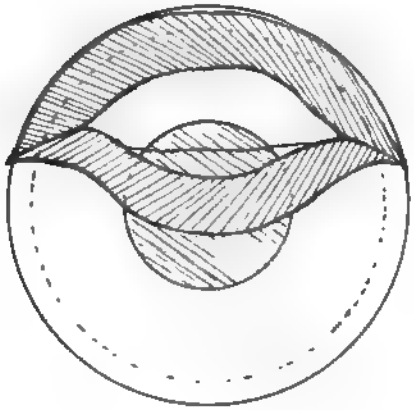


FIG. 273. Split at all points.

operations, such as delivery of the cataract and cortex and the toilet of the eye, as it is easy enough to turn it over onto the cornea. As for any hemorrhage, that may be occasioned by it, that is not to be considered at all. Just before final closure of the eye it must be seen to that the flap is nicely coapted—not caught in the cut, etc.

Could one determine with anything like certainty before operating the dimensions and consistency of the cataract, the size of the flap or of the section might be planned to suit the individual case. Since this is not feasible, it is better to err on the side of prudence and safety, by making it unnecessarily large, than to attempt the regular practice of making it comparatively small. While, of course, on general principles, small wounds are less vicious in every way than large ones, with aseptic precautions *and placed in the vascular*

zone, there seems to be no appreciable difference in the coaptation and healing properties of incisions that include from 1/3 up to as much as 1/2 of the circumference, especially if the conjunctival flap is made. For those operators who prefer to transfix the cornea by one straight forward movement of the knife, with puncture and counterpuncture in one plane, and for beginners, and all who lack confidence in themselves, the larger sections offer fewer obstacles.

CHAPTER XII.

OPERATIONS UPON THE ORBIT.

FOREIGN BODIES.

In view of the peculiarities of the subject, it is thought best to give a few preliminaries before touching upon the operative measures of foreign bodies in the orbit. The latter are, for the most part: 1. objects that have entered the orbit, as flying missles from explosions, such as fragments of iron or stone, and leaden balls; and 2. pieces left behind from articles that have been thrust into the cavity, like parts of sticks, stubs, pens, pencils, the ferules of umbrellas, etc. Hence, those most liable to these accidents are those who handle explosives or fire-arms and children who run with long, pointed implements in their hands. A large percenatge also come from stooping suddenly amidst stumps and stalks of vegetation. They usually penetrate by way of the skin of the lids or by that of the conjunctiva. Rarely, in their entry, they perforate the bony wall of the orbit, and, still more rarely, enter through the temporo-sphenoidal fissure. The distal extremity of the longer objects not infrequently penetrates one of the adjacent sinuses or the cranial cavity. It often happens that little children, because of their age, and older persons, because of their confusion at the moment of the accident, are not aware of anything having entered in the vicinity of the orbit; the only way it is discovered being through the secondary disturbances excited by the foreign body. Doubtless, in many instances, the intruder becomes so thoroughly encapsuled that it never causes any disturbance. This can be readily inferred from the marvelous manner in which, time and again, the orbital tissues have been known to tolerate foreign bodies. Enormous things have remained there for years without producing the slightest reaction. It is probable that to this cause are due many of the cases of paralytic squint, without a history, and of unaccountable monolateral amblyopia. Yet, it is a good thing for those who are uncon-

sciously carrying around foreign bodies in their orbits that they don't know it. When they have trouble from this source there is time enough to do something. Sooner or later, however, most of these orbital foreign bodies are serious enough in their effects, causing not only ocular paralysis and blindness from injury to the orbital nerves, but septic cellulitis, osteoperiostitis of the walls, and even meningitis and death. Primary involvement of the eyeball is relatively rare.

Diagnosis.—In all the recent cases the foreign body in the orbit should be removed at once, if practicable. There may be the history. of a foreign body without the local evidences, or there may be the evidences without the history, or both history and evidences may be available. In the first instances the wound of entrance may have healed or it may be overlooked. It is surprising how large an object can pass through the lids or conjunctiva and, after a day or two, leave no apparent trace. Or, if a trace be found, how insignificant it will seem. Owing to the position of the eye at the time of the penetration and the different position at the time of the examination, although the injury may be fresh, it frequently happens that a probe cannot be made to follow the track. The probing must be carried out on thoroughly aseptic principles. The probe can usually find the foreign body after a surrounding abscess has broken through to the outside. Palpation is often useful, as, by judicious pressure at different points, the sence of touch can be made to extend a long way into the orbit. When it can be done, the end of the object which has been thrust into the orbit should be carefully examined for signs that any part has been separated from it. In children who have developed exophthalmos or other symptoms of orbital cellulitis, for lack of a diagnosis, look for foreign body as the cause. It is estimated that in 75% of the cases, the foreign body is situated beneath the upper inner angle of the orbit. If other means of diagnosis fail to locate the foreign body, or, after having been located by other means, then in order to get an idea of the form and size of the object, one should have recourse to the X-rays. The methods to be followed with them are precisely the same as those given for the localization of foreign bodies in the eye.

Surgical Measures.—As before suggested, those that are not likely to give any trouble are best let alone, be they recent or old.

The great majority of the recent and a goodly per cent. of the old will, however, demand interference. Having located the foreign body, it is commonly got at by incision through the skin. As many structures are gone through as is necessary to bring the object within reach, sparing, as much as possible, all those that it would be disastrous to wound. If it is thought best to remove at the site of entrance and there is still an opening, this will need enlargement. The incision or enlargement extends horizontally or, better, parallel with the rim of the orbit, and must be free enough to allow plenty of room to work. For extra large foreign bodies situated close to the roof of the orbit, it is sometimes the considerate thing to shave the eyebrow and make the cut along the mid-line of its hair-follicles, so as to hide the resulting scar. If suppuration is present, the foreign body will, most likely, yield easily to the traction of forceps or to that of a powerful magnet. If not, the cutting may have to be extended down around it before it will come without too much violence. Should the foreign body be of some brittle material, easily broken, like dried wood, or wood and bark, it is advisable, after removing a piece, to look for more. Not long since, the writer extracted in this way three successive sections of a dead twig, the aggregate length being 2 1/2 inches. The removal having been accomplished, the cavity is cleansed, and, if aseptic, the tarso-orbital fascia is brought together with absorbable sutures, and the skin opening closed with silk; if septic, a drain is put in and only the extremities of these openings are sutured. In the event of the foreign body having pierced the cranium, unless suppuration is in progress or the injury is recent, it had better not be withdrawn. If it only enters a sinus, it should be removed, whatever the conditions. When the object is near the apex or in the spheno-palatine fossa and the globe is intact, the safest means of getting at it would be by an osteoplastic operation, after the method of Krönlein. But if the state of the eye is hopeless, as regards both vision and appearance, enucleation and then removal of the foreign body would be preferable to the Krönlein.

TEMPORARY RESECTION OF THE OUTER WALL OF THE ORBIT.

KRONLEIN'S OPERATION.

About twenty years ago, two general surgeons, working independently of each other, conceived of this operation, whereby the remoter depths of the orbit are made much more accessible than by any former method. These men were Wagner, of Germany, and Krönlein, of Switzerland. Wagner's idea was in connection with fractures and other injuries of the skull, among which were foreign bodies lodged near the apex of the orbit, and Krönlein's was to facilitate the removal of tumors of the orbit, particularly the deep-seated dermoids. To Krönlein is due the credit of having evolved suitable technic, he calling the procedure, *Osteoplastic Resection of the Outer Wall of the Orbit.*

FIG. 274.

Kronlein's Operation.—The eyebrow and the hair about the temple are shaved and the patient narcotized. The first step of the operation is the incision of the soft parts. This describes an arc on the temple, having its convexity directed forward (Fig. 274). It begins over the semicircular ridge of the frontal bone, above the angular process, and two centimeters above the fronto-malar articulation The topography of the bone here is pronounced, and the different features easily distinguished by feeling. The cut runs downward and forward till about flush with the outer rim of the orbit, where it begins to turn backward, to be carried along opposite the upper border of the zygomatic arch, near the middle of which it stops. The first portion is through only skin, fascia, and a little into the muscle. The middle and latter portions are down to the bone.

tenaculums. Now the retrobulbar compartment of the orbit is opened up. If the tumor, or foreign body, be on the outer side of the cone of recti muscles, it may be removed at once, or if it is desirable to get at the posterior pole, or if on the inner side, the externus must be got out of the way. If it suffices merely to pull it aside, so much the better. If not, it is divided just where the tendonous portion begins, and a substantial absorbable suture is put through the two ends, for the double purpose of holding them for the time being, and of uniting them on the completion of the operation. With the blunted scissors, the fibrous capsule of the globe is incised so as to expose the opticus. This nerve is the land-mark. By opening up the wound to its fullest capacity, and with good illumination, the optic nerve can be seen from its disappearance in the sclera to its emergence from the optic foramen. During further operation the globe is drawn forward and inward, and the orbital fat is pushed back with a Jäger or an Axenfeld spatula. Special care must be exercised not to injure the abducens. Other structures to be avoided are the lacrimal gland, the trochlear nerve, the intraorbital nerve, and the (unnecessary wounding of) capsule of Tenon. Through breaking the capsule of the gland a fistula could arise. Much traumatism of the capsule of Tenon might result in crippled ocular motility.

The orbital portion of the operation having been completed, the cavity is irrigated, the cut ends of the externus are approximated and the suture secured, the aponeurosis is nicely arranged, the incision in the periosteum is sutured with catgut, the big flap is replaced, and the original incision is closed with silk sutures. The usual dressing. The sutures are removed after 3 or 4 days. The healing is usually prompt. The operation, though somewhat tedious, is neither difficult of execution nor attended with any peculiar dangers.

Modifications.—There have been a number of these, but none of them has meant any radical departure from Krönlein's method. They have had reference chiefly to the form and position of the first incision, and to the size of the wedge of bone resected. In fact, its dimensions in the operation just described, are in excess of those in the original operation. The cut in the soft parts is also more extensive. On occasion, these cuts may be made yet more comprehensive. Czermak, for instance, has, in this way, removed a part

of the floor of the orbit, in addition to the outer wall, employing a tiny chain saw, starting it at the back and cutting forward by pulling. Others, again, have gone much further, making resections, definitive and temporary, of parts of the frontal, exposing the dura, disarticulating the malar, etc. Haab's criticism of this method is that it is getting outside the sphere of the ocular surgeon, while the simpler measure is well within it. Schuchardt and others have suggested forms of the saw and manners of sawing. Of course, to saw from behind forward, a perforation must be made through the coverings of the spheno-maxillary fissure through which to start the saw. This is the difficult and exacting part of it.

Of the changes in the first incision, a noteworthy one is that of Parinaud and Roche. With the view of doing away with the conspicuous scar left on the temple by the older method, these surgeons recommend a quadrilateral flap with its base directed *forward.* The incision begins at the outer extremity of the eye-brow, runs horizontally backward a distance of 5 centimeters, then vertically downward 5 centimeters, and, lastly, 5 centimeters horizontally forward. The skin covering the inclosed area is loosened to the base and turned over forward; after which the operation is proceeded with as per Krönlein. Haab's objection to this method is on the score of possible interference with nutrition of the deeper flap containing the bone, hence complications in healing.

Indications for Kronlein's operation are:

1. Retrobulbar tumors of the orbit, such as dumb-bell dermoid, cysts, etc., including cavernous angioma (Knapp[1] and a few others). Sattler,[2] of Leipsic, for example, and Golowin,[3] each has by this method actually ligated off and extirpated the affected vessels in a case of pulsating exophthalmos.

2. Tumors of the optic nerve and of its sheath.

3. Foreign bodies lying deep in the orbit, making their extraction from in front a menace to the soft structures, particularly those of considerable volume, or those that have become fast in the adjacent bones.

4. Phlegmon of the orbit, especially when there is, or is likely to be, an abscess at the apex, communicating with the posterior ethmoid

[1] Knapp, Archives of Oph., vol. xxv. 1896.
[2] Sattler, Graefe-Saemisch, vol. vi, chap. xi.
[3] Golowin, Zeits. f. Augenh., iv, S. 194.

cells or the sphenoid sinus, or a strangulating periostitis about the optic foramen, etc., causing great lowering of vision without the other characteristic signs of suppurative cellulitis.

5. Certain cases of syphilitic or tubercular osteo-periostitis of the orbital wall.

6. To get at the posterior pole of the globe for operations upon the sclera (as Müller's resection for detachment of the retina) or for the extraction of intraocular cysticercus in that region. This last would scarcely ever need to be resorted to in this country.

7. The elucidation of puzzling cases that could depend upon some trouble in the retro-bulbar orbit.

8. The extirpation of the ciliary ganglion in *glaucoma absolutum*.

9. All tumors of considerable size lying near the outer wall of the orbit, as, for instance, carcinoma or sarcoma of the lacrimal gland, whose extirpation from in front would seriously endanger the function of any important nerve or other structure. With this operation there is feeling and fumbling in the dark, risking to wound the larger vessels at the back of the globe, for instance, thereby causing atrophy of the choroid or retina in an eye whose sight might otherwise have been preserved. One is not justified in sacrificing the appearance of even a blind eye if it can be possibly avoided.

THE REMOVAL OF TUMORS OF THE ORBIT.

Tumors that are favorably situated, that is, those that do not lie behind or below the globe, and some of the deeper ones beneath the roof or in the upper inner angle, can be removed without resorting to a Krönlein operation by incisions either through the skin or through the conjunctiva. The various forms of cyst, and congenital angiomata may nearly all be extirpated in this way. The same may be said with respect to many of the sarcomata and other tumors.

The diffuse, progressive angiomata, especially in young subjects, often admit of complete eradication. Knapp has given some excellent points in this connection. He says: "To treat them with ligation, the injection of coagulating substances, electrolysis, galvanocausis, and the like is very unsatisfactory. The only way to cure

them is by extirpation. This should be done out of the healthy surroundings, avoiding cutting of the tumor. If only the afferent and efferent vessels are divided, which is, of course, unavoidable, the bleeding would not be excessive, for they, like all other orbital vessels, are small and soon stop bleeding. To avoid cutting into the tumor, and also to diminish the bleeding during the operation, I have *pressed a horn plate through the cojnunctival sac, firmly against the bony wall of the orbit behind the tumor.* This has served me a good purpose in dealing with some vascular tumors in the inner part of the orbit, which had pierced the lids and spread outside in the skin. I extirpated the orbital portion, from the posterior limit to the inner surface of the lids, but did not attack the palpebral portion at all. There was no more hemorrhage than in the extirpation of a fibroma. I expected the palpebral portion to shrink after its supply vessels had been cut off, which it did."

The best position for the skin incision is somewhere along the orbital rim. In this way the tumor is not only made most accessible, but the resulting scar is least conspicuous. Above, it is hidden by the supercilia, and in the other parts of the circuit at least *masked* by the natural sulcations of the skin. If the conjunctival route is chosen, it may be made in the fornices, or, in case of tumors at the nasal side, vertically at the semilunar fold. Cutaneous incision external to the inner canthus means cutting of the canaliculi or the lacrimal sac, as well as division of the internal canthal ligament, and is to be avoided if possible. The severence of the ligament is of small moment, comparatively, seeing that the fragments can be united with catgut, and the damage repaired. For tumors at the temporal side, when relatively small, and well forward, it were well to make the first step a free canthotomy and enlarge the ensuing conjunctival opening to the required size. A remarkably clear field for operating, in case of large tumors beneath the roof, at the supero-nasal angle, or around the lacrimal gland, may be obtained by shaving the brow, then beginning the incision on the med an line at the base of the nose, (fronto-nasal suture) extending it first upward to the level of the supercilia, thence through the median line of the hair-follicles of the eyebrow, then curving downward along the outer rim, to end on a line with the external canthus. This includes all the tissues down to the periosteum. Whenever possible,

the supraorbital nerve must be spared. The wound is gradually opened up into the cavity under the roof, and the flap thus formed is turned down over the palpebral fissure. In this way the writer has removed a dumb-bell cyst of unusual size, and a plexiform neuroma the size of a man's thumb—long axis fore and aft. These tumors reached back so far that in feeling with the little finger for their posterior attachments one could feel the sphenoid fissure. By pressing the contents of the orbit downward and forward the space is much increased in the vertical sense. It is obvious that it can be similarly increased in other positions by pressing away from the tumor, but hardly so much as from above.

Technic.—This can only be given in a general sort of way. The incision, be it cutaneous or conjunctival, is carefully deepened and retracted until the tumor can be seen, or, at least, felt. It is loosened from its surroundings mainly with the blunt dissector whenever possible. When this is not practicable, the blunt-pointed scissors or the grooved hand-chisel is used, but always guided by the tip of the finger, being always sure of the nature of the tissue which is being divided. Of the scissors, those curved on the flat are the most suitable, and, in snipping, the concavity is kept next to the tumor, and only small *bites* are taken. Moreover, the scissors should be small and delicate, so as not to take up unnecessary room. If the tumor is a cyst whose size or shape increases the difficulties, it may be drawn forward as far as possible and an incision made in the wall just long enough to allow of the contents being pressed out—or sufficient of the contents to facilitate the extirpation—when, before proceeding further, the cut is either closed tightly by stitching with strong silk or the sack is drawn forward at this point in a neck, around which a ligature is securely tied. In either instance, after the tying, the ends of thread are left long, to serve as handles by which to manage the tumor. In case of the more solid growths, a strong thread can be put deeply through the forward part to answer the same purpose. When using forceps for holding the mass, they should have broad jaws, and be provided with a lock, so that they may be handed to an assistant without risk of letting go their hold. A ligature, however, insures a firmer hold and is less in the way. Every sign of the tumor having been removed, the cavity is copiously irrigated with hot sublimate solution, about 1-2000. Whenever

it can be accomplished, the tarso-orbital fascia should be closed with absorbable sutures. The skin or the conjunctival wound is sutured with silk.

Exostoses of the orbit are rarely fit objects of surgical interference, notwithstanding the fact that the affection is not uncommon. In the great majority of instances operation is contraindicated either because of the exceeding slow growth and harmlessness of the tumor or because of the danger that would likely attend efforts at its removal. Their favorite points of origin are the roof and the inner wall of the orbit—just the places that the surgeon must hold in greatest respect. The next most frequent site is the upper inner angle, where the exostosis usually springs from the frontal sinus. Their recognition is, as a rule, not difficult; the sense of touch alone being sufficient with which to make the diagnosis, on account of their stony, fixed, lobulated feel. Radiography may be valuable for their diagnosis, as well as to get an idea of form and size. With regard to their manner of attachment to the orbit, they vary from the broadly sessile through all grades of the pedunculated, to those exceptional ones that are held merely by fibrous tissue and are movable. If it can be demonstrated that one has to do with an exostosis that is movable or has a narrow pedicle, and it is giving inconvenience or threatens any serious trouble, it is removable from almost any part of the orbit. This is the kind that originates in or about the frontal sinus. Not infrequently, however, they extend into the cranium as well, and one must beware of them. Most of those that arise from any part of the bone below the horizontal diameter of the orbit may be attacked with impunity, whether it extends beyond this cavity or not; but always for some good reason other than the bare presence, such as interference with function, deformity, etc.

In operating, first lay the tumor bare by making adequate incisions through the overlying tissues, by one of the rules already given. Incise and peel back as much of the thickened periosteum as it is possible to save. When practicable, one of the tiny saws should be used to detach the growth. If not, mallet and grooved chisel or the hand-gouge are chosen. The cutting with the chisel should be close down to the base, the "chip" being taken from the side of the tumor, and the taps of the hammer as light as is consistent

with fair progress. These precautions tend to prevent the breaking out of a hole at the base of the exostosis. The abscission completed, the periosteum is carefully arranged over the site, stitched, if necessary, with catgut, and the openings in fascia and skin closed as usual.

INCISIONS OF THE ORBIT.

These are of two kinds, *evacuant* and *diagnostic*. They are both made with the patient in narcosis if there is no reason to the contrary. Evacuant incisions, as the name indicates, are made with the object of draining the tissues of serous infiltration, extravasation of blood or of pus. They are most frequently called for in abscesses of the orbit, and in the more acute stages of cellulitis; in the latter not only for drainage, but also for their relaxing effect upon the tense, densely infiltrated tissues. If relief is not prompt in these cases, serious complications arise from the pressure, such as necrosis of the retinal elements, necrosis of the cornea and lids, etc. As soon as the swelling threatens injury, therefore, free incisions are to be made in that part of the orbit which is most involved, regardless of the formation of pus, and sufficiently deep for drainage, even if they penetrate almost to the apex. The manner of making them is by puncture, or thrust; but, unless the knife is fairly broad, it does not suffice to draw it straight out as it went in, but a little sawing motion is needed, or the knife is tilted forward in withdrawing, to extend the cut slightly. The most suitable instrument is a long, slender bistoury, either straight or slightly curved, or a full-sized Beer's knife. Both point and edge must be of irreproachable keenness. The incision can be started from the conjunctival sac for the shallower parts of the orbit, but for the deeper, they should start in the skin somewhere within the zone bounded on the inside by the cone of recti muscles, and on the outer side by the rim of the orbit. The safest places for the profounder incisions are just beneath the middle third of the eyebrow and any point below, from that level with the outer canthus to that perpendicular to the wing of the nose. The knife should be held with its flat toward the globe, and made rather to hug the bony wall of the hollow cone of the orbit than to encroach too much upon the soft parts; and, it goes without saying,

that the most important structures are to be scrupulously avoided. A narrow strip of antiseptic gauze is passed down to the bottom of each cut by means of a tent-probe. This should fit loosely that it may serve as a *drain*, and not be stuffed in tightly, to act as a *stopper*.

Diagnostic, or exploratory, incisions are such as are made with the view of ascertaining the exact nature of a lesion hidden more or less deeply from view. They are executed by thrusting or lancing, as are the evacuative kind, or by cutting, with the edge of a scalpel, carefully through the tissues. The first mode would be allowable only in the event of a liquid lesion—if, in other words, distinct fluctuation was found. Then its quality might be determined by causing it to escape through a simple puncture. If, on the other hand, the injury concerned a tumescence of greater consistence, the incision should be carried slowly and discriminately through the successive layers covering the mass, until the latter is exposed. If mere inspection of it enables one to judge of its character, well and good. If not, a portion may be excised for microscopic examination. It must be borne in mind, however, that certain of the softer sarcomata are incited to tremendous activity by interfering in this manner, and must be handled very conservatively. Above all, one must not be tempted into plunging a knife into one of these, with the view of drawing off a supposed fluid.

EXENTERATION OF THE ORBIT.

Also called *evisceration*, refers to an operation whereby the contents of the orbital cavity are more or less completely removed, and accordingly, the exenteration is designated as *total* or *partial*. Total exenteration means the removal of the entire contents, inclusive of all the periosteal lining, with sometimes the cleaning out of adjacent cavities, such as the middle nasal fossa, the maxillary, frontal, and ethmoidal sinuses, and even the spheno-maxillary fossa through the fissure of that name. Partial exenteration never comprises sacrifice of the periosteum, and, in many instances, not necessarily that of a certain portion of the other contents. Either method may involve the removal of one or both lids, provided the disease at fault has not already destroyed them. One or the other procedure is indicated in all cases where enucleation or a

Krönlein operation cannot or has not resulted in the eradication of an orbital growth which may be considered a source of danger. The occasion for making exenteration is rare, and when resorted to the total form is most often the better to select. With the perfection in methods of diagnosis, like the ophthalmoscope and the microscope, of the surgical treatment of tumors, to say nothing of their treatment by *radiation*, the sphere of exenteration has become still more limited. The *partial* method is called for in those instances where, upon the enucleation of the globe for an intraocular malignant growth, it is found that there has been a slight extension outside of the sclera; or in cases of some of the more circumscribed tumors, and those of the optic nerve and its sheath; or cavernomas, that have got beyond the bounds of the muscle funnel, particularly toward the nasal side, as evinced by the direction of the exophthalmos, etc. By far the greater number of partial exenterations, however, will be undertaken in such affections as the softer sarcomata of the orbit, or those of epithelial cancer that have extended deeply into this cavity; the last purely with the object of getting surplus tissue out of the way, preparatory to treatment by radiation. It is quite possible to change the operation to the total form after having begun it as a partial, and will doubtless be found desirable at times.

Technic of Total Exenteration.—Narcosis; preferably ether, or by means of ethyl chlorid or nitrous oxid, if the subjects are children or elderly individuals with reduced vital force. The first step of the operation is the making of a canthotomy, which should extend at least one centimeter beyond the bony rim of the orbit. The lids are then everted and stretched wide apart with lid forceps or clamps. The second step is the circumcision of the soft parts. With a highly convex scalpel a deep cut is made the entire length of the lower conjunctival fornix, and down to the bone forming the corresponding rim of the orbit. This is continued upward, along the outer cul-de-sac, inward above, and downward at the nasal side, to meet the first cut, carrying it boldly to the rim all the way. Here the lacrimal canal is to be avoided. The reason for beginning the cut below is to reduce interruption from bleeding to the minimum. The third step is the loosening of the periosteum. This is incised just on the brink of the orbit all the way around. The inner lip of this incision is loosened up slightly at the outer wall, a long,

flexible spatula or elevator is inserted, and the loosening thus begun is carried back to the apex, first at the outer side, then above, and lastly, at the nasal side. Whenever the spatula encounters firm resistance at any spot, the blunt-pointed, curved scissors are brought to its aid. This will occur, for example, at the origin of the inferior oblique, at the pulley of the superior oblique, and at the internal check ligament. The membrane strips off so easily, that after it is well started, the finger can help. In working with the spatula where the bone is very thin, as over the zygomatic fossa, without and over the delicate lacrimal bone opposite, every precaution must be taken to avoid puncturing. The same with regard to the two large fissures. When the periosteum is thoroughly loosened at all points save at the sphenoid fissure and the optic foramen, the nerves and vessels passing through those openings, together with the muscle origins, constitute the remaining pedicle of the orbital contents. The fourth step is the cutting of this pedicle. A pair of strong blunted scissors is introduced at the upper, inner angle and pushed back, their extremities hugging the bone, to find and snip the opticus as it emerges from its foramen, and the upper and inner muscle attachments. The scissors blades must not be shoved far astride the nerve, or else the ophthalmic artery, lying just to its outer side, will be wounded. If this happens there will be a gush of scarlet blood. It were better to take more than one snip. Now the cone of tissue is held toward the nasal side, while a pair of strongly curved Cooper scissors are inserted at the supero-temporal roof and pushed straight back, their convexity corresponding to the concavity of the roof, to find and cut the structures that pass through the sphenoidal fissure and the outer and lower muscle attachments. There should be no traction on the contents while these cuts are being made. It were possible thereby to cause intracranial hemorrhage. The combination scissors and vessel-clamp of Warlomont or Bettmann have been recommended for these acts. The greatest objection to them is their cumbersomeness. The exenteration is complete.

The bleeding will be profuse. Copious douching of the cavity with hot sublimate solution, 1–2000, is now in order, both for its styptic and its antiseptic properties. There need be no fear of applying this freely. After this, a wad of antiseptic gauze that has a ligature put through it (after Czermak) is pressed back into the

apex, not too tightly, a long strip of gauze packed in on top of it, and a pad of cotton laid on the lids, held on by a strip tied around the head. After these have been in for a few minutes, or long enough for the active bleeding to cease, they are removed—the wad by its string—the cavity is lightly packed with one long strip of bichlorid gauze well covered with vaseline to keep it from adhering to the sides of the cavity, the incision at the outer canthus is sutured and the bandage is put on.

Should the bleeding persist in spite of the tampon, adrenalin, the persulphate of iron, or even the thermic cautery may be called into requisition. The dressing should be changed once or twice a day, and the orbit irrigated, in order to keep it sweet.

The technic of partial exenteration is very like that just described, the greatest difference being that just sufficient of the cone of soft parts is removed to accomplish the object sought—whether it be a relatively small tumor mass, or to prepare the cavity for the ray treatment. Usually almost everything is cleared away down to the periosteum. This is accomplished as nearly as possible by stub scissors and blunt dissection, without the aid of sharper instruments.

The cavity is soon covered with a luxuriant growth of granulations, even partly filled with them. These, in process of organization and contraction, draw the lids inward, producing a ghastly cup. This can be, in great measure, prevented by opening up the cavity between the lids and the orbit about the time the granulations are at the height of their growth, and putting in a lead or a tin plate covered with Thiersch grafts, raw side out—an artificial conjunctival sac, as it were.

One or both lids may have to be removed because of infiltrations of the growth, or, as said before, they may have been already destroyed by the disease. The defect thus left may be covered later by a pediceled graft from the temple, or by Thiersch grafts. The plan suggested by Noorden, of covering the entire cavity with epithelial grafts the moment the operation is finished, does not give as good cosmetic results as when one waits for the granulations to partly fill the orbit.

When there was no involvement of the lids, Langebeck, in order to preserve them, in a case of very large tumor, circumcised them, except a pedicle, 2 centimeters wide, at the usual side. The

skin of this area was dissected up to the pedicle, and turned over the nose, to be stitched back in place after the enucleation.

The writer, in the case of a young woman with recurrence of sarcoma in the region of the lacrimal gland, after enucleation and partial exenteration had been resorted to in vain, was enabled to save the lids and the conjunctival sac. The incision extended from about 2 centimeters below the outer canthus around the upper rim, to end in the median line of the nose. The flap thus outlined was dissected up without injuring the conjunctiva, the exenteration made and the flap returned. When the lids are conserved, there is generally an unseemly gaping of the palpebral fissure. To obviate this, Küster recommends tarsorrhaphy of all save the inner angle. In such cases, the writer would suggest thorough resection of the tarsi, and the preservation of the follicles of the cilia.

Knapp says that exenteration sometimes saves or prolongs life, and sometimes shortens it. And Panas, "Unfortunately, recidivations are always to be feared, and, in cases of sarcoma, especially glioma, the tumor is reproduced with desperate tenacity, and all the more quickly in proportion as the interventions are repeated."

CHAPTER XIII.

THE REMOVAL OF FOREIGN BODIES FROM THE INTERIOR OF THE EYE.

Foreign bodies within the eye are threatening or dangerous to the integrity of the organ in accordance with:

1. The degree and nature of the traumatism they produce in entering. This may be due to direct wounding or, as in case of hot substances, to burning.

2. The condition of the injury with respect to infection, either carried in by the foreign body itself or occurring from without. This may vary from absolute immunity to the presence of sepsis in the greatest virulence.

3. Their location. Those lodged in, or in contact with, the uveal tract, causing the greatest reaction; next, those in the vitreous body; then, the retina, and, lastly, those in the lens.

4. Their chemical composition. Such as are readily oxidizable, like copper and iron, being more potent for evil than the noble metals or even than lead and zinc. Copper, according to the investigations of Leber, has the property of giving rise not only to violent uveitis, but also to suppuration, whether in connection with pathogenic germs or not. The different intraocular tissues exhibit about the same relative tolerance of the decomposition as of the presence of the foreign body.

5. The extent to which they become encapsuled, i.e., with organized blood-clot or inflammatory exudations.

6. The duration of their abode. The longer the time, the less likely they are to give trouble.

7. Their qualities with respect to diagnosis, recognition, or localization. Glass, for example, is one of the most difficult of substances to find with the eye and to extract because of its transparency. True, it is rather opaque to the X-rays. Others, again, are transparent to these rays, and escape observation through obscuration of the media. Still others, of whatever composition, elude all forms of search by their minuteness.

Anterior Chamber.—Probably less than 25% of the foreign bodies that enter the eye find lodgment in this chamber. If they have great velocity or striking force, they mostly go beyond, and if the contrary, the great majority fail to pass beyond the cornea and sclera. Many of those that do stop here are of the *transplantation* kind, i.e., the extraneous substance is carried in by the implement that makes the corneal wound, instead of making an opening for itself. In this way cilia, bits of bark, earth, etc., get in, and, in addition, an implantation cyst of the iris may develop. With the exception of the lens, the anterior chamber tolerates foreign bodies better than does any other part of the eye: hence, one may be more deliberate in putting into effect plans for their removal than if they were in the uvea or the vitreous. If obscured by blood, one may usually wait for the latter to be absorbed. If the history indicates the presence of iron or steel within the eye, steps should, meanwhile, be taken to locate it, and if found in this place, it should be at once removed. Infection also requires prompt action. This is not to intimate that any foreign body should be allowed to remain in the anterior chamber if there is a fair chance of removing it. Far from it. The usual mode of determining their presence is by ocular inspection, aided, if need be, by direct and reflected illumination, and by the binocular, or stereoscopic loupe. Often the closest scrutiny and the strongest focal illumination are necessary. Siderosis of the iris, or the characteristic iron-rust tint, is a pretty sure sure sign that a foreign body is in that membrane or elsewhere in the uvea, or has been. In rare instances the foreign body may be got out through the wound of entrance, though this may have to be enlarged; if of iron, with a magnetized probe, with the tip of a hand magnet, or, without inserting an instrument, with the giant magnet; if nonmagnetic, with Knapp's spoon or with suitable forceps. Nearly all, however, will necessitate incision at another place. Even in case of still patent entrance wounds, if the body is small, and has lodged at a distance from the wound, it is best to make an incision at a near-by point. The removal is facilitated if the keratotomy lies close down to the iridic angle, so that the substance can slide out on the iris without being caught behind the posterior lip of the cut. It is desirable that the traction instrument pry the incision open as little as possible, to avoid needlessly spilling the aqueous. When

the anterior chamber is empty, the foreign body is caught between the iris and the cornea, and if the foreign body is angular, or jagged, it will then catch or sink deeply into the iris and be impossible to extricate without undue violence. A sharp projection may, in this way, be even driven through the capsule of the lens, causing traumatic cataract. If working under such difficulties, lay a pad of cotton, wet with boric acid, over the closed lids, and wait for the secretion of more aqueous. There is no need of hurrying. In the event of its being a bit of iron or steel, there is no question but that it should be got out with a magnet, the one question being as to the *kind* of magnet, magnetized nickel-plated iron probe (or solid nickel), tip of hand-magnet, or the giant magnet. Great attracive force is rarely needed, and if exerted will often cause a prolapse of iris, hemorrhage in the anterior chamber, and pain and wincing on the part of the patient. A magnetized probe is a poor instrument as compared with a properly constructed hand-magnet. There would be many an occasion on which the control of the current causing the traction would be of decided advantage. Most eye surgeons agree in pronouncing the smaller magnet more fitting than the larger when it comes to work in connection with the anterior chamber. Sometimes a silver or horn iris spatula can be of great assistance by slightly prying open the incision, and by holding back the iris. Its use is especially recommended if there is a tendency of the cut to strip the foreign body off the traction instrument, be it probe or magnet tip. If the foreign body is fast too tightly, either by being pinched between cornea and iris or by entanglement in the latter, to come out with moderate attraction, and if waiting for the chamber to reform, together with the use of the spatula, do not help matters, it were better to resort to the iris forceps for its withdrawal than to throw on the full power of a giant magnet. This seizing the foreign body with the forceps is of course at the risk of bringing the surrounding portion of the iris out with it. The best form of iris forceps is that without teeth, having, instead, slight serrations athwart the inner aspect of the jaws. A forceps with teeth is apt to make the foreign body jump away. In seizing the foreign body as little of the iris should be included as can be. Yet as much as comes out with the forceps were best snipped off. A clean coloboma is better than a mangled and poorly replaced segment of iris. *An*

iridectomy, however, is by no means inevitable in these cases. Haab declares that he has not found it necessary to resort to it in extracting iron from the anterior chamber with his large magnet. Even when the fragment has lodged firmly in the iris at the time of the accident, it is sometimes possible to draw it free into the anterior chamber with the magnet before making the corneal section. Failing to do

FIG. 276. Use of hand-magnet for foreign bodies in anterior chamber. Forefinger is on make and break button

so, excision of the surrounding portion of the membrane is unavoidable. Indeed, if the bit of metal stands up well abovet he iris, i.e., is held merely by the loose, fibrinous anterior portion thereof, incision and forceps extraction alone may better suffice dispensing with the magnet. I saw my colleague, Wilder, recently remove such a foreign body in this manner without disturbing the iris, notwith-

standing the fact that it had been there for a long time. Foreign bodies that lie so as to involve the uveal lining of the iris are not so well-borne as the more superficial ones. The above points in technic apply equally well to foreign bodies of the iris and to those that are free in the anterior chamber.

The most suitable tip for the hand-magnet in this connection is the short, thick, curved one, which rapidly tapers to a point. Its wedge-like form serves to widely separate cornea and iris while the foreign body is being withdrawn (Fig. 276). The current should not be turned on until the extremity of the tip is about in contact with the piece of metal.

In the Posterior Chamber.—It has been denied that foreign bodies ever find their way primarily into the posterior chamber. That its existence is only assumed, there being really no place between the anterior capsule of the lens and the posterior surface of the iris. That those bodies that have got in between had first been in the anterior chamber and secondarily—while the patient was in the recumbent posture, for instance—slid over the pupillary border. With this in view, Hodge advises that mydriatics be omitted when dealing with a foreign body loose in the anterior chamber. A case reported by the writer in Knapp's Archives would seem to disprove these assertions. It was that of a chemist who had a glass flask burst in his face. There was a flap-like perforation of the cornea, and straight back of it an abrasion of the lens capsule, but no corresponding trace in the substance of the crystalline. The eye was kept under constant observation for two weeks, during which time there were several exacerbations of iritis. Repeated and exhaustive searches were made for a foreign body by myself and others. None was found. The eye became quiet enough for the patient to leave the hospital. He went home, and shortly after his arrival, while stooping to examine the grate-bars in his furance, he felt a peculiar startling sensation in the eye. The eye became red and painful, and he came direct to my office. The first glance showed a cube-shaped bit of glass lying at the bottom of the anterior chamber, having undeniably dropped through the pupil at the moment the head was lowered and the pain had occurred. It was promptly removed, but with iridectomy, and the eye has given no further trouble. Now, this man came for treatment immediately

upon receiving the injury, his pupil had not been dilated, neither had he lain down. The glass had evidently stuck lightly to the front surface of the lens for a short while, then worked its way down into the posterior chamber.

In the Lens.—The crystalline is wonderfully tolerant of foreign bodies. So much so that it will sometimes retain perfect transparency for months, or even years, with one imbedded deeply in its substance. Even fragments of copper have nothing like the deleterious effect on it that they have in other parts of the eye. Often the worst that ensues is a cataract, and this may be only partial. No one would, of course, think of making discission of such a cataract and thus risking to turn the foreign body loose in the eye. To extract it would be justifiable, but only under certain conditions, among which would be a defective fellow eye, signs of irritation from the foreign body, or the fact of the patient living in a remote district, etc. These remarks refer only to the cases of known foreign bodies in the lens. Given a transparent lens with foreign body visible therein and a perfectly quiet eye, certainly no intervention would be warranted, save, perhaps, in the event of the substance being iron or steel. The great surety and safety with which the magnet and a skillful operation could deal with the situation might—probably *would*—overbalance the risk of leaving it there.

In the Vitreous.—The surgery of this subject is of recent date. This is one of the few fields that surgeons in ancient, and olden times in general, fought shy of. The first authentic record of the removal of a foreign body that had been wholly within the vitreous chamber was that by Albrecht von Graefe, about 65 years ago. Then followed similar operations by Edouard Jaeger, of Vienna; Critchett, of London, and by Desmarres, of Paris. The extraction was with forceps, through the wound of entrance or through a scleral incision.

It is an etablished fact that at least 60 to 65% of the foreign bodies that are driven into the depths of the eyeball come to rest in the vitreous chamber. Experience has proved that 65 to 70% of the vitreous foreign bodies are magnetic, i.e., of iron or steel. Not to exceed one-third, then, are left to be treated by surgical measures other than magnet operations. The latter will be referred to further on.

A foreign body in the vitreous is a very grave affair, whatever its nature. Sooner or later, with but few exceptions, the sight is lost, and in the vast majority the eye itself is destroyed. Worse still, a large percentage of the instances of sympathetic ophthalmia have occurred in consequence of a foreign body in the vitreous of the fellow eye. Some sort of intervention, then, is the rule. After what manner proceed? In this connection are offered the following indications for intervention and abstention, partly adapted from Coppez:

1. If the foreign body is voluminous and has penetrated with considerable force, apparently destroying the globe at once, and panophthalmitis is imminent, exenterate or enucleate immediately.

2. If the traumatism is moderate and the media are sufficiently clear to admit of seeing it, or it can be definitely located by any means, one might, by an ample meridional scleral incision, and with the aid of a suitable traction instrument—say a forceps, a spoon, or a hook—and guided by a mirror secured in front of the eye of the operator, essay to catch and withdraw it.

3. If the media have lost their transparency, thus shutting off any view of the interior of the eye, and other methods of localization prove negative, although there may be fair perception of light *and the eye remains irritable*—exenteration.

4. If there is no perception of light and it is known that there is a foreign body present, and the eye is sensitive or irritable, exenteration at once.

5. If an eye with a foreign body in the vitreous is perfectly quiet, particularly if some time has elapsed since it entered, it is probably well encysted. Here, whether the eye is hopelessly blind or not, intervention is not indicated. Instead, the patient is instructed to watch closely and to report any signs of disturbance in the eye to a competent oculist. This is particularly true of certain small particles that can be seen with the ophthalmoscope.

6. Not having succeeded in removing a foreign body and if the reaction is serious and the ultimate good of the eye is dispaired of, exenteration or enucleation, when possible, there and then. It is the proper thing in all the desperate cases to inform the patient that, in case the foreign body is not recovered, the removal of the eye or its contents might be the only other expedient, and to get

his consent to the further operation if the operator deemed it advisable. As to the choice between exenteration and enucleation, the first is preferable except in cases where there would be risk through its selection of overlooking a dangerous foreign body in the orbit.

In all recent cases it is most imperative that steps, looking to the riddance of the eye from a foreign body be taken at the earliest moment possible. The same may be said of the old cases that have but lately become inflamed because of the presence of one. Moreover, the mere fact that foreign bodies have been known to lie in the vitreous from 20 to 40 years without inciting mischief is no sign that this will happen in any given case. Nor is great length of abode within the eye of necessity a bar to intervention.

Magnet Operations.—The history of the removal of foreign bodies from the vitreous has been made mainly since the use of the magnet in the surgery of the eye. The first tentative in this connection was an ineffectual one by Meyer, of Minden, in 1842. The next, perhaps, was by Dixon, of London, in 1859, who succeeded in removing part of the blade of a pair of scissors that had been in the vitreous for four weeks. The steel could be indistinctly made out through the pupil. By means of a large, permanent magnet it was drawn close to the outer wall of the globe and extracted with forceps through a scleral incision. The eye was lost. It is only since 1870 that the magnet has acquired any real importance in the ophthalmic world. Previously, all eyes with foreign bodies in the vitreous had been considered either as doomed or else as bearing the sign "hands off!" Hence, no instrument had been designed for the extraction of a foreign body from any part of the interior of the eye. Knapp's spoon-hook for foreign body in the anterior chamber was about the first. In 1875, M'Keown, of Belfast, went further than had Dixon, in that he inserted the tip of a magnet through a scleral opening into the vitreous, and succeeded not only in removing the foreign body, but also in saving the eye. This was the first instance in which the magnet was made to enter the eye. His example was soon followed by his compatriots, Snell and MacHardy, who published articles commending the method. The idea was taken up by Knapp, Grüning, and others in America; Grüning giving a very effective and convenient permanent hand magnet. To Hirschberg, of Berlin, however, belongs the credit of having rendered

the procedure practicable. This was through the invention, in 1879, of his electro-magnet. Notwithstanding he length of time, this instrument has held its own, and is still the favorite of its kind. It is a most valuable acquisition to the eye surgeon's outfit, and has the remarkable record of having extracted up to 75 and 85% of magnetic intraocular foreign bodies. Many of the failures were doubtless due to the fact that the metal had not been located. The magnet, together with a storage battery to energize it, can be easily carried. Or it may be put in connection with the wires for interior incandescent lighting. Hirschberg has recently had constructed a more powerful hand-magnet. These magnets have lifting powers ranging from 1/2 to 2 pounds—sufficient for all ordinary work—and with the addition of accumulators, etc., their pull may be still further increased. It seems strange to note that, as late as 1881, Dr. Paul Berger, of Paris, found but 31 instances in all literature of extraction of a foreign body from the poster:or segment of the globe. Sulzer, realizing that the horse-shoe form g ven the ordinary permanent magnet furnishes the greatest relative tractive force, has modified the Hirschberg magnet thus: The core is of soft iron in the form of a horse-shoe, with ends closely approximated The extremity comprising the two poles is made of two separate parts, isolated, magnetically, by a piece of copper, on the opposite side of which they diverge like a fork whose two tines fit into the members of the core.

In 1881, MacHardy suggested approaching the eye supposed to contain a magnetic foreign body to a large magnet, actuated by a powerful electric machine, with the view of ascertaining if there would be any sensation in the organ indicative of the presence of the metal.

In 1886, Hirschberg began his valuable series of publications detailing his experiences and his views relative to work with his electric hand-magnet (Fig. 276).

In 1892, Haab, of Zürich, conceived his "giant" electro-magnet, and found that with it a magnetic foreign body could be drawn from the farthest limits of the vitreous chamber, through the lens and pupil, into the anterior chamber, by the mere application of the tip of the magnet to the cornea. At the International Congress at Rome in 1893 he recommended the "giant" electro-magnet not only

for diagnostic purposes, but for the extraction of the foreign body as well. Haab's great magnet consisted of a soft iron core, 60 centimeters long and 10 thick, and weighing more than 75 pounds. This was wound thickly with small copper wire, the whole weighing 300 pounds. Obviously, this is too heavy an instrument for carry-

FIG. 277

ing. Since its appearance, many modifications have been manufactured, some still more powerful, and others, while but little inferior as to the force they exert, are so condensed, as to size and weight, as to make them readily portable. These are attached to the ordinary lighting circuits, of 70 to 110 volts, having a strength

of 20 to 33 ampères, with or without rheostats. The current may be either continuous or interrupted. Storage batteries can be also employed to stimulate them, the minimum current for the ordinary giant magnet being one of 30 volts. The large magnets have lifting forces varying from 1/2 pound to 2 pounds. They are supported on tables, like Haab's, or suspended by pulleys from the ceiling, like Mayweg's, or pivoted by universal joints to a wall-bracket, like Volkman's. One of the handiest I have seen is that of the Victor Electric Company, of Chicago (Fig. 277). It is hung by a movable articulation to an adjustable arm, similar to the davit of a boat. This, in turn, rests on a platform with rollers. At first costly, the price has now been so far reduced that these magnets are within reach of almost any specialist, and each of them who has not access to an eye hospital where the instrument is kept, should possess his own.

Both large and small magnets are furnished with tips of varying forms and lengths. To increase the length of the tip, however, and to reduce its thickness are equivalent to increasing the distance of the magnet from the eye, and as the attractive force is in inverse ratio to the square of the distance, short, blunt tips will, on the whole, prove more satisfactory. In order to increase the suction area, as it were, or sticking surface of the tip, instead of being round or cylindrical, they are better made ovoid or elliptic (in cross-section).

Localization.—Taken as a whole, the results of magnet operations are not so brilliant as some might be led to imagine—especially when a liberal allowance is made for unreliability of statistics. According to Hurtzeller, who has gone over these very carefully, out of 313 attempts to extract steel or iron from the vitreous, only 65% succeeded. Of these, a certain degree of vision was preserved in 22%. It is acknowledged that more than half of the entire number eventually came to enucleation—how many more are not reported. Doubtless, the number of successes would have been much higher had the most approved methods of localization been employed, or *could* they have been. This is the greatest essential What are the means to this end? They are:

1. Circumstantial evidence.
2. Ocular Inspection.

3. The ophthalmoscope.
4. The sideroscope.
5. The roentgen rays., i.e.,
   - *a*. The fluoroscope.
   - *b*. The radioscope.
   - *c*. Radiography.

Circumstantial Evidence.—By far the greater number of fragments or missiles that strike the eye are so minute, and so lacking in velocity and impact that they fail to enter at all. Of those that penetrate the vitreous chamber, the big ones have mostly caused destruction of the eye directly or indirectly before it reaches the surgeon. The vast majority of those he is called upon to seek in the vitreous, and to extract, are small—that is to say, just large enough so that, when traveling at the rate of ordinary flying particles, they have striking force sufficient to pierce the cornea, iris and lens, or the sclera and its coverings. Larger ones, traveling with greater speed, such as bird-shot, are more apt to pass through the entire bulbus. The circumstances of the accident, examination of tools, etc., may give an idea as to the form and size of the foreign body; and the direction of the flying particle with reference to the position of the eye at the time of the injury may suggest its location. Upon the size of the foreign body depends, in great measure, the size of the wound. But it must be remembered, that a long, slender projecti e will, if it strikes endwise, leave but an insignificant wound, and *vice versa*.

Inspection.—If the injury is recent, there are usually objective as well as subjective signs of it. These are: *Externally*, redness and swelling of the lids, and of the conjunctiva, and evidences of a wound. If the latter is in the cornea, there will be, *internally*, a corresponding one in the iris or in the lens, or in both, not always visible. The track of the foreign body through the crystalline may be in evidence—it may not be as it is often by way of the zonule. There is often blood, and sometimes pus, in the anterior chamber, and this may hide the signs in iris and lens. When visible, these consecutive wounds give a good idea of the direction of the foreign body, and something as to its location. If the wound is in the sclera it, too, has a story to tell as to the size and direction of the foreign body. Again, inspection may fail of results here, because

of swelling and inflammation. It is well to bear in mind not to give undue credence to the statements of the average patient.

The ophthalmoscope, in the relatively few instances when it reveals the foreign body, is the best means of localization we have for the posterior half of the vitreous chamber, as, in addition to the exact spot, it shows something of the size of the foreign body and something of the nature of the bed in which it lies. It is also useful in tracking the metal through the media, by means of traces of blood, exudate, air-bubbles, etc. At times, when not capable of revealing the thing itself, it may, at least, indicate its hiding place. Rarely it shows siderosis of the vitreous in the vicinity of the foreign body.

The Sideroscope.—The first to apply the principle of the magnetic needle for the purpose of ascertaining the existence of iron in the eye was Poolly, of Brooklyn, who, in 1880, published the results of his experiments in Knapp's Archives. Shortly afterward Thompson and Widerman each suggested a form of *galvanometer*. These contrivances, while based on true scientific laws, proved insufficient for detecting the presence of any but relatively large masses of metal. In 1894, Gallemaerts presented to the French Society of Ophthalmology the *magnetometer* of Gérard, which was an improvement on the instrument of Pooley, it having had the power of responding to a bit of iron within the eye weighing as little as 1/2 milligram. This should be sensitive enough of all practical purposes of diagnosis, seeing that the weight of the particle is rarely below 2 milligrams. The sideroscope of Asmus, which has had considerable vogue, was still more sensitive than that of Gérard. Like that of the latter, the needle is suspended with a single long strand of the silk-worm's web. The only material difference is that in the Asmus sideroscope the ordinary magnetic needle is interchangeable with an astatic needle. The variations of the needle are observed from a distance of 3 or 4 meters through a telescope similar to that used by surveyors. The greatest objection to this form is its extreme sensitiveness, making, when near objects of iron or trolley and arc-light mains, for instance, its readings misleading. Hirschberg is the inventor of a sideroscope, or "Eisenspäher," somewhat less sensitive and much less complicated than that of Asmus. In it he dispenses with the telescope, and has a small lamp

flame reflected onto the scale that indicates the oscillations of the needle. The manner of operating the sideroscope is to approach the needle to different parts of the globe and note its deflections; these are greater the nearer and heavier the piece of iron. It is difficult to manage. Knapp, in referring to the Asmus model says: "To handle it requires the patience of a saint." With Hirschberg's also, the same precautions must be taken relative to the proximity of iron or of electric currents. Even particles of iron in the hair or beneath the scalp such as iron-workers are apt to have will affect the needle.

Roentgen or X-rays furnish the best known means of locating foreign bodies in the vitreous chamber, whether the substance be of iron or of other material opaque to them. From the time of their discovery by Roentgen, of Würzburg, until 1896, the refracting media of the eye were thought to be opaque to these rays. The crystalline, in particular, with its index of refraction so nearly the same as that of glass, was considered impervious to them. This was the explanation offered as to their invisibility. In March, 1896, Van Duyse made the first radiograph of a foreign body in the eye, and the delusion was dispelled.

X-rays afford so far three methods of application to the localization under discussion, viz.: fluoroscopy, radioscopy, and radiography. The first two depend for their value upon the properties possessed by certain substance of becoming luminous under the influence of the X-rays, such as the platino-cyanid of barium and calcium tungstate. In the fluoroscope, a small screen covered with one of these materials is fitted to a dark-chamber that can be held to the eyes of the examiner. In a darkened room the screen is placed close to the eye to be examined, i.e., against the face or the temple. The Crooks tube is set in operation from a point opposite, and the observer sees a skiagram of the eye and the other tissues through which pass the rays coming to the screen, and he is supposed to determine whether, in addition to the normal shadows, there is that of a foreign body. Unless the subject be a child, whose bones are more permeable, or the foreign body be rather large, these methods are unsatisfactory.

Radiography.—This gives the most exact and approved means of localization of any yet discovered. It owes its worth to power

of the X-rays to make an impression upon an ordinary sensitized photographic plate. The skiagram is thrown onto the plate and, after ordinary development of the latter, is reproduced in negative form, i.e., the shadows are the clearer or lighter places. A positive printed from this constitutes the radiograph. When viewed from the *glass side* of the negative, the lights and shadows appear in their true relations—not reversed, so that a positive is not always needed. There are three ways of utilizing the radiograph for the localization of foreign bodies in the eye and orbit. These may be designated as:

1. The graphic.
2. The stereoscopic.
3. The geometric.

1. **The Graphic.**—This consists in making two exposures with the eye at the same distance from the tube, but with a change of 90° in the view-point. For the right eye, for example, the plate would be placed against the right temporo-palpebral region and the tube at the left—this for the first exposure. For the second, the order would be, the plate against the closed lid of the right eye and the tube back of the head, and slightly to the right side, in both instances having the point of emission of the rays as nearly as possible in line with the center of the eyeball that is exposed. The two views will give the approximate position of the foreign body with respect to the center of the globe and to the sclera, provided certain guide-marks are employed in connection with the exposure, and a control radiogram of about the same aged subject, with limits of the globe outlined (Fig. 291) be used in the viewing. This is the quickest way, and sufficiently accurate for most cases. It would have to be an urgent case, with the necessary apparatus at hand, that could not wait for it. The localization could be effected, if need be, on the wet plate immediately after fixing. Two circles, each with a radius of about 1/2 inch (somewhat smaller for a child), could be struck on the film or the glass, its position regulated by the guide-marks and by the control picture. One of the best indicators of the position of the globe in the radiograph is one of the tiny wire eye-masks of Webster Fox, particularly the one having a circle to fit round the cornea. With this in place, and having the eye fix

an object so as to make the circle coincide or parallel with that of the circle of the cornea base, a fairly accurate guide is obtained for plotting the sclera in both views. It must be seen to in the lateral exposure that the plate is parallel with the sagittal plane of the eye, and, in the other, that this plane is perpendicular to the plate.

2. **The Stereoscopic.**—This method involves the psychic element that is concerned in binocular single vision. In other words, it gives to the otherwise flat skiagram its third dimension, enabling one to perceive the relative positions of the objects there outlined in relief or perspective as well as laterally. The points of emission of the X-rays from the tubes during the exposure are separated horizontally by a distance corresponding to that between one's eyes, the rays from each made to fall on its own half of the plate, thus producing a double radiograph. The resulting skiagram is viewed with a stereoscope. The process is well adapted to physical examination elsewhere, but poorly to that now under consideration chiefly on account of lack of definition because of the smallness of the object sought, of the heavy bone structures through which the rays must pass, and the feeble illumination.

3. **The Geometric.**—This method is based on the principles of geometry as applied to mathematics; that is, the result is obtained by the construction of diagrams or actual working models, together with numerical calculation. There have been a number of plans worked out on these lines by different individuals, some simpler, some more complicated; some requiring elaborate paraphernalia, some scarcely any beside the X-ray apparatus. They start from the same beginning, and all arrive at substantially the same result, but by different routes. As a beginning, two shadows, or projections, of the foreign body in connection with the shadows of two or three other near-by objects of known position, are photographed on the same plate. Both exposures are made with a single tube, which is moved a definite distance between the two, or they are made simultaneously, by using a pair of tubes. The exact location of the foreign body is then determined by triangulation. The result is accurate to a degree, in all of them. Only two, as being among those most often chosen, will be dwelt upon at any length here. One is by Sweet, of Philadelphia, and another by Guilloz, of Nantez.

Method of Sweet.—Sweet, of Philadelphia, has designed a local-

izing method consisting of two metal indicators, one pointing to the center of the cornea and the other situated to the outer canthus at a known distance from the first.* Two exposures are made in order to give different relations of the shadows of the indicators and of the body in the eyeball, one with the ray tube horizontal or nearly so with the plane of the indicators, and the other with the tube below this plane.

The principle of this method may be understood from the prospective drawing, Fig. 278. Rays coming from the light situated at A cast shadows of two ball-pointed rods and an object in the eyeball, and give the view shown on the surface C. In this instance the tube is in front of the vertical plane of the two indicators, and consequently the shadow of the center ball will be thrown back of that of the outer ball. When the light is carried below the plane of the two indicators, the shadows of the two rods are formed on the surface D, and the shadow of the foreign body in the eye assumes a new position. If the distance of one of the indicating rods from the center of the cornea is known, and the distance between the two indicators is measured, the position of the metal in the eye may be determined, since the shadow of the foreign body preserves at all times fixed relation to the shadows of the indicating balls in whatever position the light is placed.

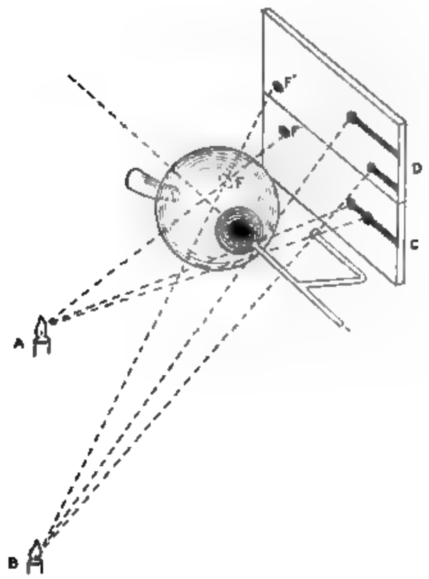


FIG. 278.—Principle of method of localization (Hansell and Sweet.)

Accurate localization requires that the axis of the eyeball shall be parallel with the two indicators and with the photographic plate,

* The methods of Sweet and their description are taken partly from the work of Hansell and Sweet on "Diseases of the Eye," and partly from a paper read by Sweet at the meeting of the American Ophthalmological Society, July, 1909.

that one of the indicating balls be opposite to the center of the cornea and at a known distance from it, and that both indicators are at a measured distance from each other. The plate-holder and indicators have been combined into a special apparatus which is bound to the side of the head, as shown in Fig. 279. The arrangements of the parts of this apparatus are such that the indicators, while freely adjustable, are always parallel to each other and to the plate, and the two balls are perpendicular to the plate and 15 cm. distance between their centers when the apparatus is in place. It is necessary that the patient rotate the eyeball to bring the ocular axis parallel with the plane of the photographic plate, and that the operator adjust the indicators so that the center ball is opposite to the center of the cornea.

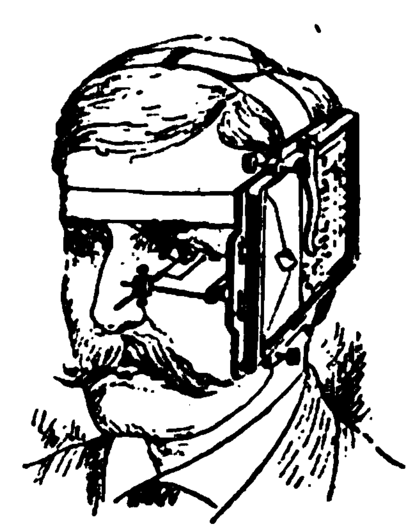


FIG. 279.—Indicating apparatus secured to side of head. (Hansell and Sweet.)

To determine the position of the foreign body in the eye, two circles are drawn representing the horizontal and vertical sections of the normal adult eyeball, and upon these are marked the situation of the indicating balls at the times the radiographs are made.

Lines are drawn through the shadow of each of the indicating balls on the two radiographs. On the negative made with the tube horizontal and parallel with the plane of the indicators, a measurement is made of the distance the shadow of the metallic body is above or below the shadow of each of the indicators. This distance is entered above or below the spots representing the two indicators on the diagram of the vertical section of the eyeball. Thus, in the radiograph (Fig. 280) the distance of the foreign body below each indicator (OS and NS) is entered below the spots A and B, front view, Fig. 281. A line drawn through the points C and D gives the direction of the X-rays at the time the shadow of the foreign body was cast upon the plate.

Similar measurements of the distance the shadow of the foreign body is below the shadow of each of the indicators are made on the second negative, and these measurements are likewise entered below the points A and B, representing the two balls on the vertical sections of the eyeball. These measurements are AF and BF. A line

drawn through the points E and F gives the direction of the rays when the second negative was made. Since these two lines indicate the plane of the shadow of the foreign body at each exposure, the intersection of the lines must be the location of the metal in the eye as measured above or below the horizontal plane of the globe and to the temporal or nasal side.

To determine the distance of the foreign body back of the center of the cornea, the negative made with the tube horizontal is taken. and the distance is measured that the shadow of the ball opposite the center of the cornea lies posterior to that of the external ball.

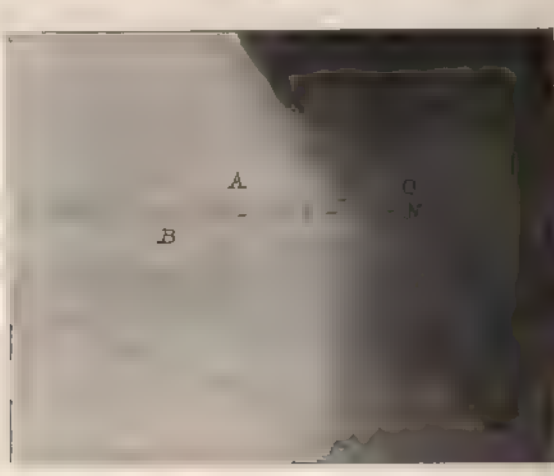


FIG. 280. Radiograph made with tube near plane of indicators (Hansell and Sweet.)

This distance is entered directly above the external ball on the diagram representing the horizontal section of the eyeball. A line drawn from K through he center ball gives the direction of the rays at the time the radiograph was made On the same negative is measured the distance that the shadow of the foreign body is back of the shadow of each of the indicators. and these distances. B J and A H, are entered on the diagram. A line drawn through the points J and H and, since this line represents the plane of the shadow of the foreign body, the point at which a perpendicular drawn from the situation of metal, as shown on the vertical section of the eyeball, intersects this line indicates the situation of the body back of the center of the cornea. If the position of the tube from the eye has

been measured, its distance is indicated on the line drawn from K through the center ball A. A line through J to this point indicates the divergence of the rays. This means of determining the position of the plane of shadow of the foreign body is more accurate than when the measurement is made of the shadow of the body above each of the balls, and should be followed especially if the body is some distance away from the anterior segment of the globe or is in the orbit.

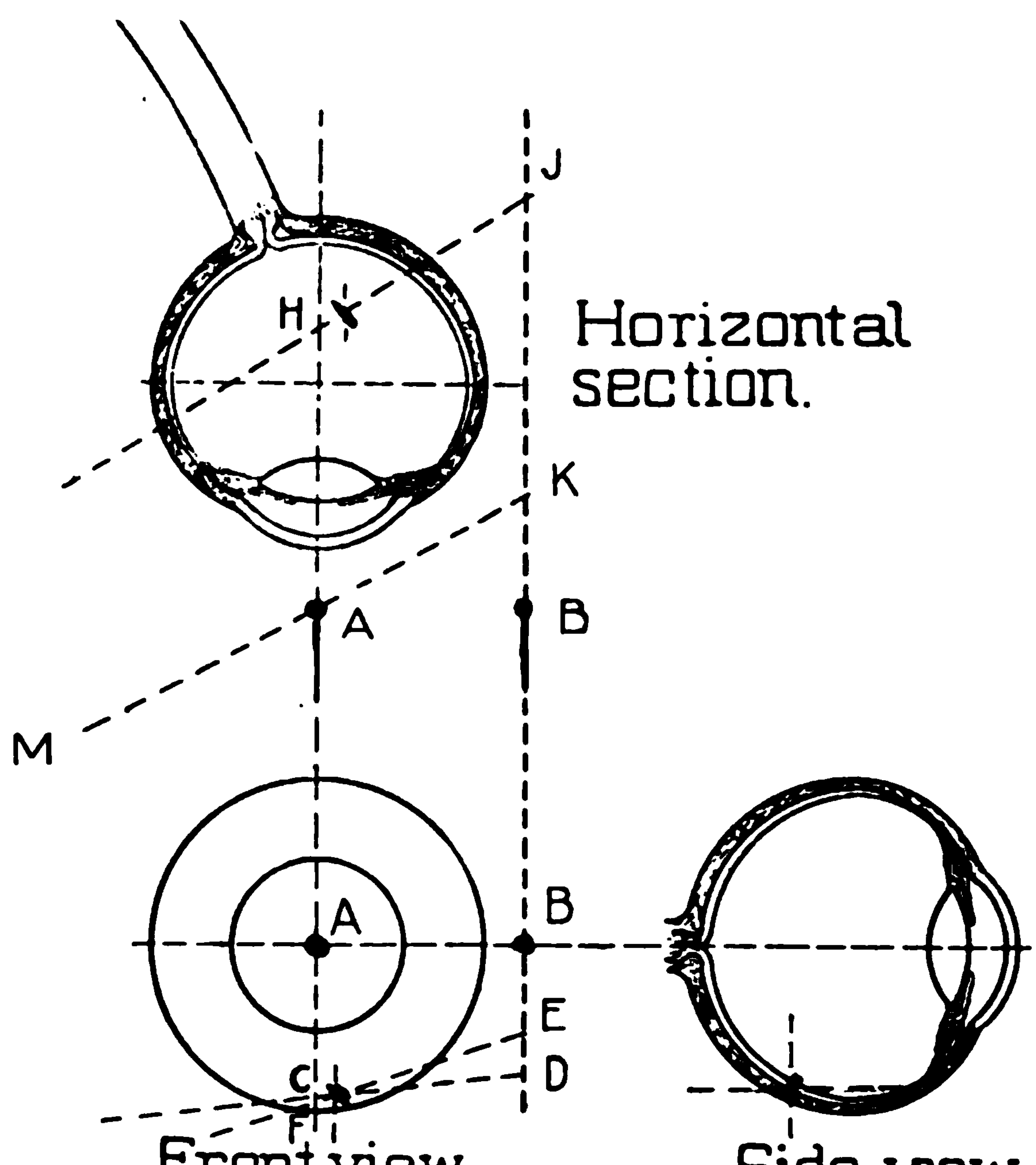


FIG. 281.—Diagram of position of foreign body in eyeball. (Hansell ond Sweet.)

If the foreign body has passed into the orbit, the rotation of the eyeball to insure parallelism of the ocular axis with the plane of the plate leads to a slight error in the determination of the position of the metal. To eliminate this error necessitates a knowledge of the angle of the orbit with the plate or, its equivalent, the amount of deviation of the eyeball from the primary position and the consideration of this angle in plotting the diagrammatic circles representing the eyeball.

The indicating apparatus is secured to the side of the head corresponding to the injured eye, and the tube placed about 12 or 15 inches to the opposite side and slightly forward. The patient is in the recumbent posture to insure steadiness of the head. After the indicating rods have been adjusted, the patient fixes an object about 5 to 10 feet distant, so placed that the visual axis of the injured eye shall be parallel to the photographic plate. An exposure of from one to two minutes will clearly outline the bones of the orbit and secure a shadow of any body opaque to the rays in the eyeball or in its neighborhood.

Sweet's New Localizer.—At the last meeting of the American Ophthalmological Society, July, 1909, Sweet presented a simplified method of localization. The new form of apparatus exhibited in this connection, while it embodies the same principles as that just described, is so constructed that it relieves the operator of the necessity of making measurements from the radiographs or of drawing any lines to represent the planes of shadow. "In the new apparatus the planes of shadow of the foreign body are accurately determined by the instrument without the necessity on the part of the operator of taking measurements from the plates or in drawing lines on the chart. The tube-holder, indicating ball, and plate-holder are upon a movable stage, and therefore preserve a known relation to each other which does not vary. The angle of the rays with the eyeball and the distance of the tube from the plate are always the same, so that one indicator is sufficient, and this consists of a small steel ball supported in a metal ring. The setting of this ball opposite the center of the cornea is made by means of adjusting screws conveniently placed on the frame of the instrument. Accuracy in the measurement of the distance of the indicating ball from the center of the cornea is secured by means of a telescope and reflecting mirror. The mirror gives an image of a cross-wire and a lateral image of the cornea. Through the telescope the observer adjusts the instrument until the image of the cross-wire is in direct contact with the image of the summit of the cornea. (Fig. 282.) When the adjustment is made, the indicating ball is exactly 10 mm. from the center of the cornea. A miniature incan-

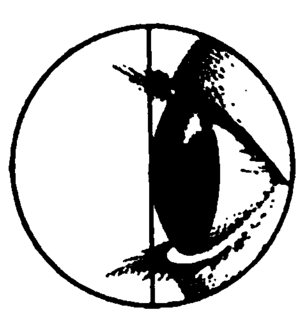


FIG. 282. Image of cross-wire and cornea. (Sweet.)

descent lamp, mounted in an adjustable shade, illuminates the side of the nose of the patient, insuring a well-lighted image of the cornea and cross-wire.

"Instead of a ball of cotton or other object for fixation, as in the older method, a circular mirror is placed at a distance of 12 inches above the injured eye. The patient gazes in the mirror and sees a reflected image of the injured eye and the circular celluloid disk with the steel indicating ball in its center. After the ball has been

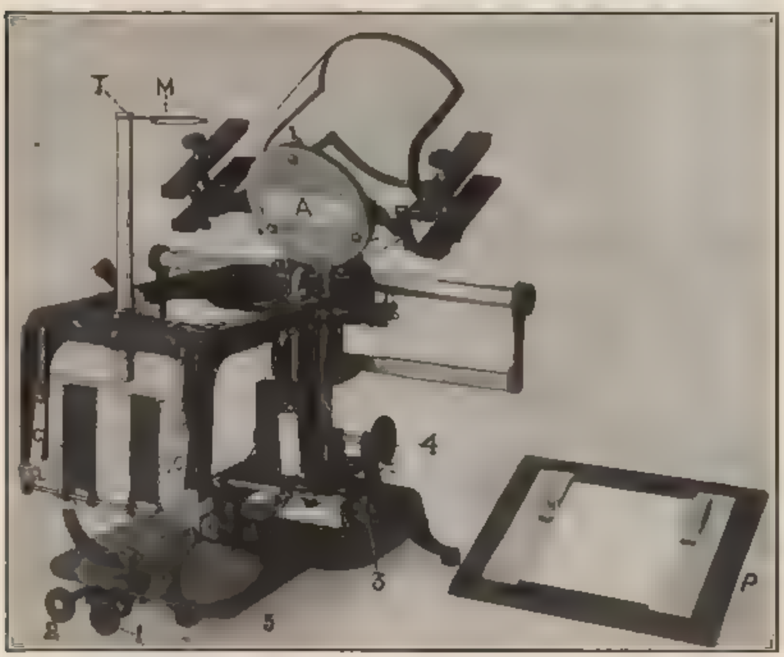


FIG. 283.—(Sweet.)

adjusted to a point opposite the center of the cornea of the injured eye, the patient by fixing the ball with the seeing eye prevents any movement of the eye during the exposures and holds the visual line of the injured eye parallel with the plate.

"In order to shorten the time of making the radiographs and lessen the possibility of any movement of the patient or apparatus in changing plates, the two exposures in the new apparatus are made upon one plate, metallic shutters protecting those portions of the plate which are not to be exposed to the rays.

"The tube-holder contains the usual cylindrical lead glass shield for protecting the operator from the action of the rays, with the customary lead diaphragm. The central orifice of the diaphragm is covered with aluminum, which offers little obstruction to the rays, but lessens the risk of any unfavorable action of the rays upon the patient and guards against possible damage to the eyes in the event of breakage of the tube. The tube holder slides upon a graduated rod, and the first exposure is made with the indicator at

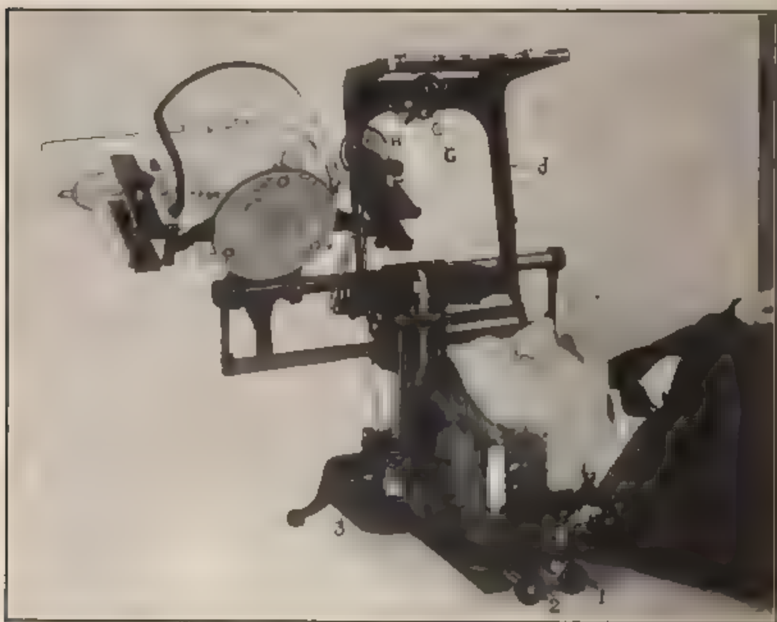


FIG. 284.—(Sweet.)

zero, in which position the rays pass in a direction corresponding with the horizontal plane of the eyeball. The second exposure is made with the tube at its farthest point to the right or left of the first position, depending upon which eye is to be examined. The illustration (Fig. 283) gives a view of the complete apparatus.

"Since the relative position of the tube in reference to the indicating ball and the photographic plate remains fixed and known, it is readily seen that the direction of the X-rays in passing through the eyeball must follow a definite course, which is always the same for

the two separate exposures. It is, therefore, possible to indicate on the localization chart the direction of the rays at the two exposures, and this has been done in the chart, a copy of which is reproduced in Fig. 285, reduced in size one-half. Only those lines representing rays 2 mm. apart are reproduced, but each line is drawn with the

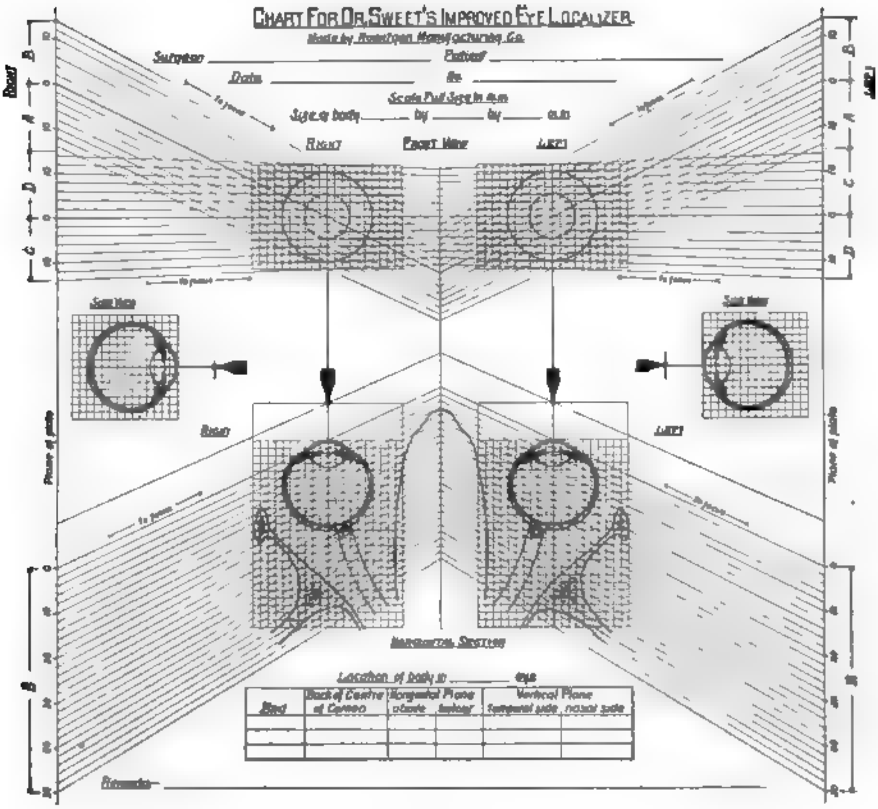


FIG. 285. - Localization chart, with lines representing course of the x-rays one-half actual size. (Sweet.)

required amount of divergence to indicate the rays as coming from a point the distance of the tube from the photographic plate.

"METHOD OF EMPLOYING THE NEW LOCALIZER.—The apparatus is arranged as shown in Fig. 284. The patient lies with the head on a platform of hard fibre, with a pillow beneath the shoulders and a small sand-bag under the head and neck. The upright

supports for holding the head are now adjusted by means of the wheel 1, and the jointed part of the apparatus, J, containing the indicator is brought down in position. The indicating ball, G, is now roughly adjusted until it is opposite the center of the cornea and about 12 or 15 mm. distant. The patient looks with the uninjured eye into the mirror, M, and fixes upon the iris or cornea of the injured eye, or, better, upon the indicating ball in the center of the celluloid disk. The indicating ball is now carefully adjusted directly over the corneal center by means of the wheels 2 and 3, and the correctness of the position verified by observation through an opening in the mirror, M. The operator then adjusts the light of the small electric lamp so that the side of the nose next the injured eye is illuminated, but the light is not thrown into the eye. With this area lighted it is possible to see clearly through the telescope, T, when the cross-wire is exactly tangent with the summit of the cornea. The movement necessary to secure this position of the wire is made by means of the adjusting wheel 4. When the image of the cross-wire touches the image of the corneal summit, the indicating ball is exactly 10 mm. from the eyeball.

"The photographic plate is inserted beneath the spring clips, C C, the shutters, S S, moved so that the center area is open (Fig. 283), and the tube-holder adjusted to the zero-point on the sliding scale. The current is turned on, and one exposure made. The tube-carriage is then moved to the limit of the sliding rod, always in the direction of the chin of the recumbent patient (to the end marked R if the radiographs are made of the right eye, and to L if of the left eye). The upper shutter is moved to cover the exposed central portion of the plate and uncover the upper unexposed portion. The current is again turned on and the second exposure made. The time of exposure for the second picture should be about one and a half times that of the first, to allow for the increased distance of the tube from the eye.

"After the plate is developed it is placed in the frame, P (Fig. 283), containing the key-plate or focal coordinates (Fig. 286), with the film side of the radiograph next to the key-plate. The radiograph is moved until the shadow of the indicating ball of the first exposure is in apposition with the middle ball on the key-plate and the heavy horizontal line of the radiograph parallel with the horizontal line

on the plate. Holding the frame to the light, there is noted the position occupied by the shadow of the foreign body with respect to the vertical lines of 'C' and 'D.' A reading is made of the line or lines which pass through the body, and this is transferred to the corresponding lines of the 'C' or 'D' scale of the chart, to the right or left side, depending on which eye is under examination. Without moving the plate the 'E' reading is similarly made and transferred to the chart. To take the 'A' or 'B' reading, the plate is shifted slightly until the image of the indicating ball on the

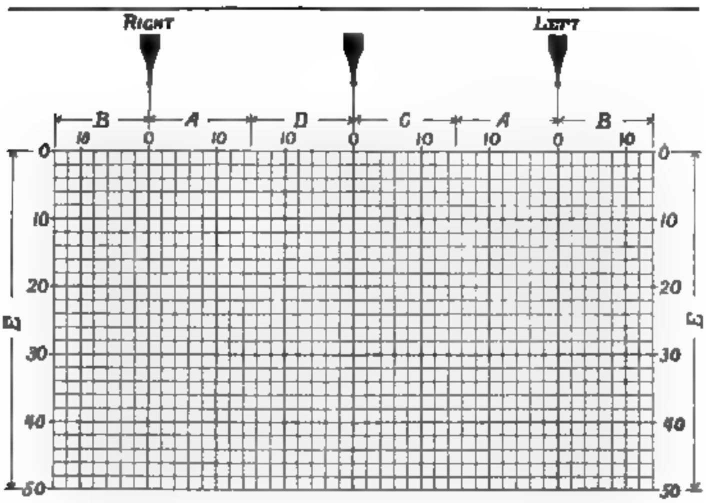


FIG. 286.—Plate showing focal coördinates three-fourths actual size. (Sweet.)

second exposure coincides with the 'Right' or 'Left' ball of the vertical coordinates 'A' or 'B.' The line or lines of the 'A' or 'B' coordinates which cross the shadow of the body are noted and indicated on the 'A' or 'B' lines of the chart. The horizontal coordinate 'E' should be the same in both readings. If the focus point on the anode of the tube was accurately set by the cross-lines on the lead-glass shield of the tube holder, the images of the indicating ball on the plate will coincide simultaneously with those on the transparent key-plate, and it will then not be necessary to reset the plate to read the position of the 'A' and 'B' coordinates.

"After the three readings have been transferred to the chart, the

point of crossing of the 'A' or 'B' and the 'C' or 'D' lines is found, which gives the location of the foreign body in reference to the front view of the eyeball, indicating its situation above or below the center of the cornea and to the nasal or temporal side of the vertical plane. Where a vertical line from this point crosses the 'E' reading on the horizontal section of the globe it gives the depth of the body in the eyeball or orbit In bodies of large size both ends should be localized to give the position in which the body rests in the globe. The situation of the body on the side view is determined by transferring its measured depth from the horizontal

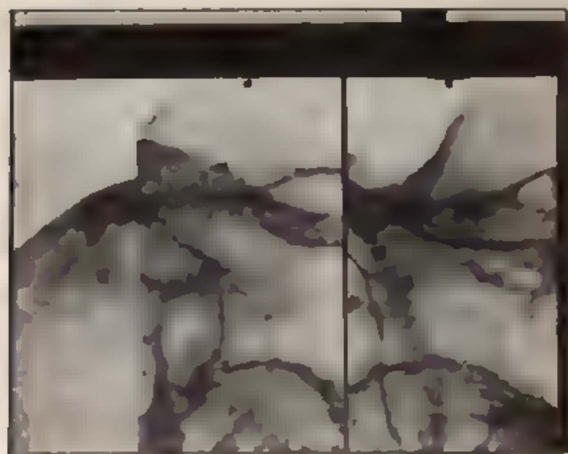


FIG. 287.—Radiograph of foreign body in eye three fourths actual size (Sweet.)

section and its distance above or below the horizontal plane from the front view localization.

"The new apparatus is based upon the same general principles as was the old, but its mechanical features eliminate some of the errors that may occur in the use of the present instrument through carelessness of the operator in making the measurements and transferring them to the chart. The inexperienced worker in eye localization is also relieved of the necessity of studying out the position of the tube and the direction of the lines of shadow at the two exposures The construction of the new apparatus insures that these factors are positively determined and recorded. The accuracy of the localization depends only upon the care with which the

operator adjusts the indicating ball opposite the center of the cornea and at the definite and fixed distance from it. After the exposures are made and the plate developed, the determination of the situation of the foreign body is simply a question of reading from a key-plate and transcribing these readings to the chart."

Mackensie Davidson secures equally accurate results in the localization of foreign bodies in the eyeball by means of special form of apparatus and the use of particles of fuse wire placed at points near the orbital margin. The planes of shadow of the foreign body at the two exposures and their point of crossing are indicated by means of threads.

Method of Guilloz.—Two tubes, capable of separate adjustment, have their anticathodes on the same level. A sensitized plate, enveloped in black paper, is placed, horizontally, 50 centimeters below them. A fine wire fastened around the plate gives the projection of the line joining the anticathodes, and two metallic guide-marks, placed on this line, indicate the centers of emission. Three metallic guide-marks are glued about the orbital rim of the subject, one just external to the supraorbital notch, one directly below, and the third at the external rim. The subject lies with the side of the head which corresponds to the affected eye resting on the plate. The eye is immobilized by having the subject fix some object immediately in front of it—not in the median line.

The two tubes are set in action, and the exposure made to last from two to four minutes. Thus are obtained double shadows, or biconic projections, i.e., of the metallic markers, as also of the foreign body. These biconic projections are transformed either by a diagram or by calculation into right-angular lines that give the distance between the markers themselves and their distances from the foreign body. The distance between the markers being directly measurable, one thus obtains a verification of the result. Moreover, before beginning the calculations, or the drawing of the diagram, it is necessary to be assured that the lines joining the homologous points of the double images are parallel with the line left on the plate by the wire that has been stretched across it.

Guilloz has demonstrated on the head of a cadaver that the method is exact to the fraction of a millimeter. The manner in which the head reposes on the plate does not have to be determined in accordance

with the findings. It is only necessary to see that the head and the eye remain immovable during the exposure, a fixation apparatus not being necessary. Be it understood that the degree of precision that we have indicated is that obtained *geometrically;* this is not usually the case when the localization geometrically attained is transformed to conform to the three markers in the *anatomic* localization—it may be by reason of the variable dimensions of the orbit or it may be owing to the mobility of the eye.

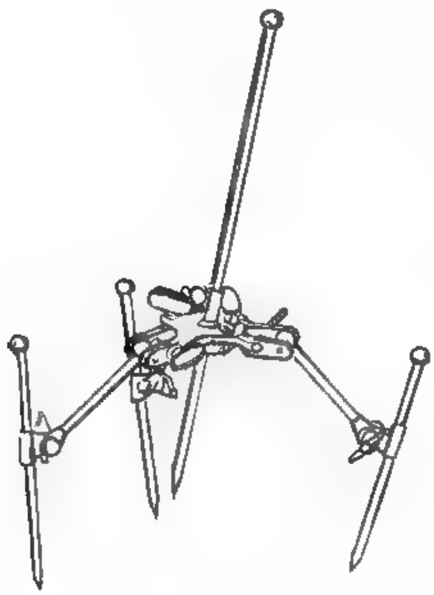


Fig. 288.—Method of Guilloz for localization of foreign bodies (iron or steel), in the eye.

The distances of the foreign body from the three guide-marks having been determined, it remains to make the anatomic localization. This is accomplished with the aid of markers by employing an instrument which is nothing more than a compass with four branches, each of which may be set for whatever inclination or whatever length is desired (Fig. 288). The head of the compass is formed of a plate through whose center runs the median branch, and carries on its periphery the three upper articulations of the arms that support the other branches. The central branch is a graduated, rectilinear, cylindrical stem, sliding, with light friction, in a hollow shaft one centimeter in length. This, at its center, passes through a copper ball to which it is soldered, and which works in a spherical concavity situated partly in the plate and partly in a flange fastened by three screws on top of the plate. A little turn given to one of these screws renders the articulation rigid, by pressure, and permits only the sliding of the graduated branch in its collar. Each lateral arm is biarticulate, the upper extremity being attached to the plate by a ball-and-socket joint similar to that described for the central branch,

and which can be made rigid by the action of a thumb-screw. The lower part of each arm is fitted with a hinged articulation, carrying a short, hollow cylinder, through which slides a lateral branch, and that is also provided with a thumb-screw to make it rigid.

Assuming that the distances separating the guide-markers, one from the other, is known, as also those of the foreign body from said guide-markers, to adjust the compass a triangle, A B C, is constructed (Fig. 289), whose sides represent the distances between the guide-markers. The points of the lateral branches of the compass are placed on the three points of the triangle and set with the thumb-screws. The central stem is pushed down to fall at the point X in

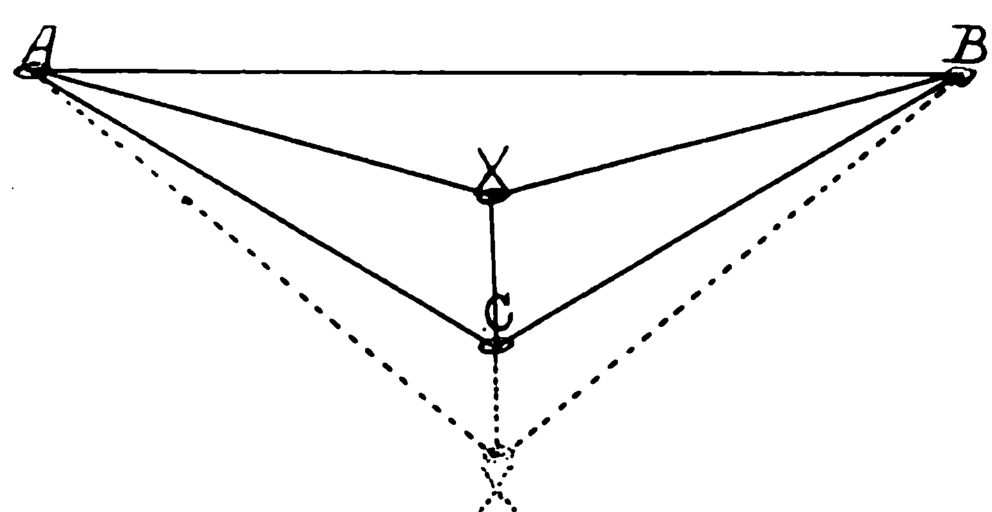


FIG. 289

the triangle, and the distanceXA, XB, and XC are found by stepping. Now, to facilitate the regulation of the compass, take a bit of perforated lead, X, attach to three other bits of lead, A, B, and C, by wires; the points of the branches are struck into the corresponding leads, and the central branch is pushed down until the wires are stretched. The compass thus adjusted, the distances are verified by means of ordinary dividers, and hearrangement is perfected by stepping. The result obtained, the central stem is set tight by the screw in the flange, and the mark on the graduated scale that is flush with the top of the collar, is noted.

If the compass were placed on the subject's head, the points of the lateral branches in contact with their corresponding guide-markers, the direction of the central stem would indicate the position of the foreign body, for if it were pushed down to the point noted on the scale, its point would rest upon the said body. The process is not only accurate, but simple. The shadows on the photographic plate (or positive), together with the known distance of the tubes from

the plate, furnish all the information needed to determine the situation of the foreign body.

The general plan is illustrated by the accompanying figure 290: Let B represent the foreign body S S′ the points of emission of the rays—from two tubes at once or from the same tube in different positions. The conic projection of B on the plate P gives us the two points b, b′. The positions of S S′ and b b′ are known, and their distances, one from another, are measurable. Hence, to determine the position in space occupied by B, all that is required is to join *b′* to S′, and *b* to S, either by real lines, as of wire in the apparatus,

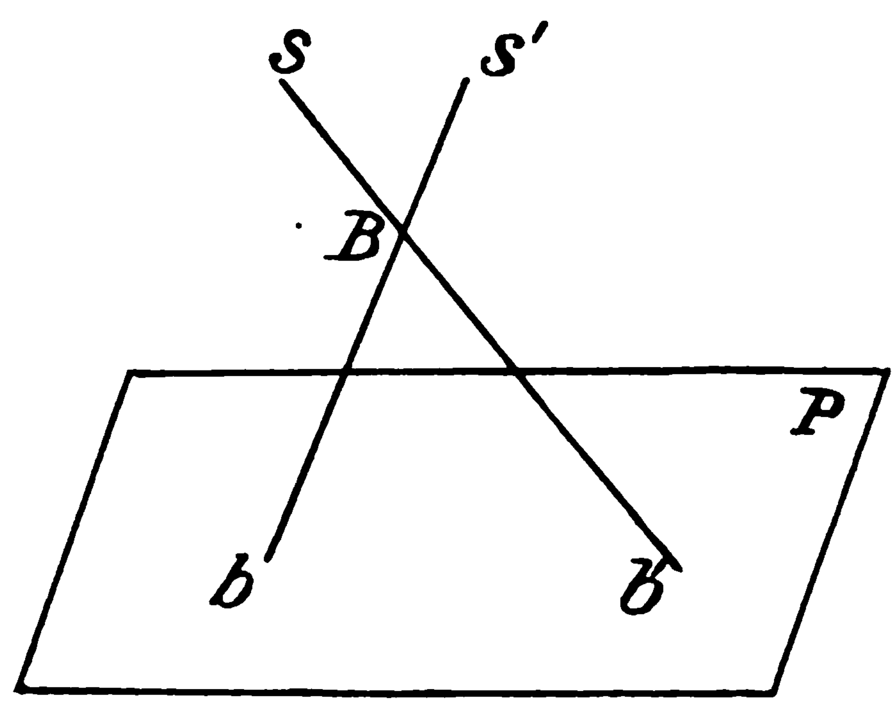


FIG. 290.—Guilloz's method of localization of iron in eye.

or by lines traced on a diagram wherein the points S S′ and b b′ have been placed. This first process absolutely determines the point B holds in space. Its relative position can then be ascertained with relation to certain guide-marks.

To Control the Eye.—The direction of the eye should be the same at the time of the exposure (or exposures) to the rays as at the time of the surgical intervention. Omit this precaution and the whole procedure of localization comes to naught. A small sheet of metal is pierced with a round opening the size of the cornea. When this is placed in front of the eye it is easy to make the circle of the cornea correspond to that of the aperture. To this sheet of metal are fastened three legs or processes that extend just to the centers of the guide-marks placed on the orbital rim. At any time that it becomes desirable to reproduce the position the eye was in at the time

of the exposure, it suffices merely to place the processes on the corresponding guide marks, then cause the cornea and the opening to coincide. Guilloz claims to have accurately located by the foregoing method a piece of steel weighing only 1 milligram. None of the methods are infallible. The severest tests of the two just given are when dealing with a very minute foreign body situated far at the opposite side of the eye from the tube, or in line with the denser bone shadows that are interposed. Here they may fail.

Choice of Relative Positions of Head and Tube. To obtain a radioscopic view or to make a radiographic exposure of the eye that shall be least obstructed by surrounding bone are matters worth considering. Figs. 291 to 294 are from radiographs of the

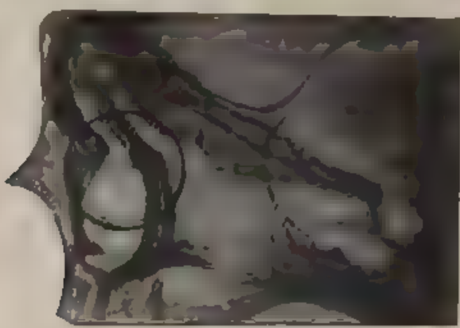


FIG. 291. Perpendicular.

orbital region made by Guilloz, and are adapted from Volume IV of the French Encyclopedia of Ophthalmology. The black circle represents the globe of the eye. These pictures were made with the view to ascertaining, by shifting the relative positions of tube and head, how great is the interference of the heavy shadows of surrounding bone with the area occupied by the eyeball. The left eye is in question; i.e., the plate is fixed to the left temple. In each instance the distance from tube (or point of emission of the X-rays) from the photographic plate is 60 centimeters, and the plate is placed parallel with the sagittal plane of the head. In the first exposure, Fig. 291, the long axis of the head was at right angles to the tube. About one-half the shadow of the eye is covered by the dense shadow of the external rim of the orbit. Now, in proportion as the tube is moved forward, or as the head is inclined to the right,

the circle representing the globe is disengaged more and more from the dark streaks of bone shadow. The second exposure, Fig. 292, was made with the tube at an inclination of 10° to the first, Fig. 293 at 20°, and Fig. 294 at 30°. It will be seen that in the last

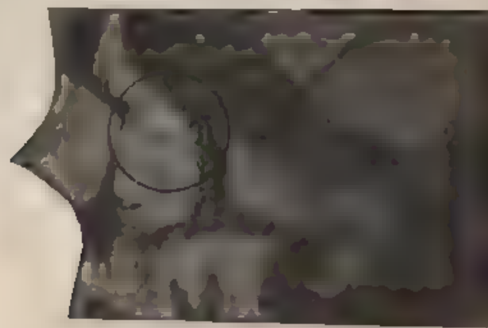


FIG. 292. At an inclination of 10°.

radiograph the globe stands out clearly defined in a relatively shadowless space. At a still further inclination, the disengagement would be even more complete, but the distortion caused by the obliquity of the projection would be so pronounced as to render the result valueless.

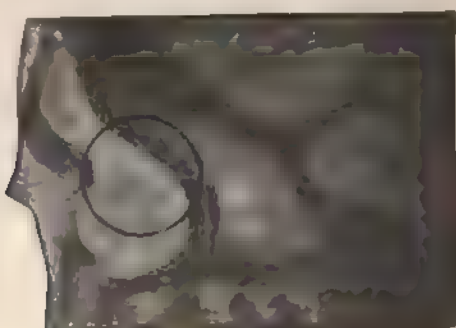


FIG. 293. At an inclination of 20°.

The X rays serve to locate most species of wood, glass, stone, and all the other metals as well as iron and steel.

The proper distance of the tube from the plate is from 40 to 50 centimeters (16 to 20 inches). Since the rays emerge from the anti

cathode divergent like a cone, the further away the plate, the more magnified, yet the less distinct the shadows and the longer the exposure. The center of the anticathode should be in line with the center of the rotation of the exposed eye. To have the subject in the recumbent posture during exposure is conducive to accuracy, as the motions imparted to the head by the heart, in breathing, and by the muscles concerned in equilibrium are then most nearly eliminated. It is advisable to cover the eye not concerned—better still, to bandage it firmly. The patient may lie on the back with the plate bound to the temple and the tube at the opposite side or

FIG. 294. At an inclination of 30°.

on his side, with the temple on the plate and the tube or tubes directly above. When the foreign body has but recently entered the eye, it may be susceptible of movement in obedience to the laws of gravity. It would then be important that the same position be assumed in exposure and in extraction.

The dangers and inconveniences of the X-ray to both examiner and examined should not be ignored. They mainly concern the skin of the operator's hands and the skin and hair of the patient's head. Trophic disturbances are common: brown discoloration, erythema, etc. Gangrene, with subsequent deformity of the fingers, can occur.

Comparison of the Methods of Localization. To put it concisely, circumstantial evidence, the patient's statements or those of others, and ocular inspection are all very good as far as they go, but cannot be trusted to any considerable extent. The ophthalmoscope is preferable to any other means, but, unfortunately, it is

so handicapped with restrictions that it seldom has an opportunity. The sideroscope has the advantage of being ready, favoring despatch, and also of indicating whether or not the foreign body is magnetic. Its use, however, is limited by its sensitiveness to surroundings and by its inability to respond to very small foreign bodies when situated in the posterior segment. Moreover, it takes no cognizance of foreign bodies other than those of steel or iron and is troublesome to manipulate. Of the X-ray methods the graphic is a method of expedience, and, in common with the others in the same group, it can make known the presence of a foreign body of other material than iron and gives an idea of form and volume. Radioscopy and fleuroscopy are serviceable on occasion, i.e., for the larger foreign bodies, but, as a rule, are unreliable. The objections to stereoscopic radiography have already been given. So that, after all, geometric radiography is the method of general utility, since it tells nearly all that any of the others can and tells it more accurately; though, as has been seen, it, too, has its limitations, not the least of them being the time it consumes. Yet, with everything at hand, the negative radiograph can be produced in half an hour.

The Technic of Magnet Operations.—It is assumed that the piece of metal has been located in the vitreous by one of the modes just given, or else that this has been impracticable and that the time has come to operate. Shall it be the smaller, hand-magnet, or the giant, or both? This is a matter of choice and circumstance. For the case in point we will select the smaller, but have the other in reserve, and will discuss the *pros* and *cons* of the two instruments further on. Indeed, those who are in no way prejudiced may, on occasion, have recourse to both at a single sitting. The eye is prepared and the patient is put upon the table and narcotized. Unless there is some good reason to the contrary, it is best to have him asleep, in order to insure freedom from pain and squeezing, with needless escape of vitreous. If the injury is recent and the wound is in the sclera, and the foreign body has been located nearby, the coverings of the globe are incised and retracted and the bleeding is stanched. At this stage, if the wound is well back, fixation forceps are employed to gently rotate the eye without pressure. The tip of the magnet is inserted a very little way, without previous enlargement of the scleral openings, if it be adequate. If not, it is

extended sufficiently with blunt-pointed scissors. When the tip is thought to be near the metal, the circuit is completed by pressing the button on the magnet, holding the magnet still for a few seconds. If the foreign body is attracted to the tip, and is of fair size, there will be a slight shock, and a click denoting that it is caught. All that remains is to withdraw the tip, all the while pressing down the button. Should the foreign body be very small, there will be no evidence of having brought it to the magnet, and the instrument must be withdrawn and the tip examined. A tightly coapting wound may tend to strip off the foreign body. In that case its lips will have to be parted with tiny, nonmagnetic retractors or a more suitable tip substituted. It need hardly be stated that neither iron, steel, nor nickel instruments are admissible at the time the magnet is working; they must be of brass, aluminum, German silver, hard rubber, etc. Those that are not used in conjunction with the magnet, such as scissors and knives, may be of the usual kind Not succeeding at first in bringing out the object sought, the tip may be inserted again and again, gently feeling about in the vicinity, making and breaking the circuit at intervals, and taking care not to disturb the vitreous more than is prudent. Poking and fishing desperately and deep are disastrous and inexcusable, whether the foreign body has been definitely located or not. Failing still, resort should be had to the more powerful magnet rules for the manipulation of which will be given later. Having recovered the foreign body, the site of the operation is cleansed, the scleral opening, if large or inclined to gape is closed by a fine, absorbable suture or two, superficially placed, he membranous opening sutured with black silk, and the eye bandaged. Often it is better to omit stitches from the sclera. The metal not having come to light, it is a question of more accurate localization and another magnet operation, of exenteration, of enucleation, or of temporizing, and its decision must be left to the judgment of those in charge.

Supposing that the wound of entrance is not available through which to extract; that the foreign body has been located at a distance from it; or that it has long since healed; or that penetration has been by way of the cornea. In any case the scleral incision is in order. This should be as near to the foreign body as the situation will allow. If making it in an unfavorable spot—i.e., unfavorable

to the general good of the eye—can be avoided by going in just a little to one side of the metal; this ought to be done. In this manner the recti muscles, the trunks of the vorticose veins, the larger vessels of the retina, etc., may escape needless injury. All things else being equal, the best place for the incision is that recommended by Arlt—between the tendons of the *externus* and *inferioris*. The next best, between the latter and the *internus*. The tissues overlying the sclera are incised, meridionally, for a distance greater than is desired for the deeper cut. Retraction and stopping of the blood, as before. The scleral incision is made with a good Graefe knife, either by puncture and counterpuncture or by shallow perpendicular puncture, for one extremity, and slight sawing to complete. It should lie in the middle of the first opening and parallel with it. Its length, to be adequate, will usually be about one centimeter. The rest of the operation is carried out as described in the preceding paragraph.

Operation with the Giant Magnet.—The greatest authority on the handling of this instrument is its inventor, Professor Haab, hence, most of the points here given are borrowed from him. The surgeon, assistant, and spectators put aside their watches to prevent damage to their mechanisms. The patient, with eye made ready, sits on a strong, firm stool, facing the working end of the magnet. There are certain advantages in having the instrument suspended in pivotal joints. Great store is set by having the patient in such a position that the head can be freely moved by the operator in every direction, so that he can give notice of sensations produced by the foreign body, and by having him conscious. Moreover, it is appropriate that the patient be suffered to start back when he is hurt by any movement of the foreign body, and get away from too strong a pull which might do harm. This he could not do were he recumbent. Therefore, both operating-table and narcosis are dispensed with. A drop of cocain may be instilled. If the patient is docile, neither speculum nor fixation forceps are used, as they would simply be in the way. Haab no longer employs a rheostat, but allows the current to go directly to the instrument, increasing and decreasing the force by advancing and retiring the subject's head, and making and breaking the current by means of a pedal. There can be no objection to the rheostat provided it does not materially

decrease the attractive force, and that there is a switch between it and the magnet. An assistant is stationed at this, whose sole duty is to throw it "On!" and "Off!" at these words of command. Another assistant is commissioned to do the illuminating with some form of artificial light; another to work the lever of the rheostat, if there is one. If the wound of entry is still patent, it is usually chosen for the

FIG 295.

point of exit also, though it may need to be slightly extended. When in the sclera, conjunctiva and other superjacent tissues are got out of the way by incising and retracting, and the scleral opening is cleaned up by snipping off tags and shreds that extrude. If the course of the foreign body in the eye has been traced, one endeavors to make it retrace the same. By so doing, additional wounding of the structures is avoided. The hair of the subject is snugly covered

by a rubber cap. The operator grasps the head with both hands, and directs the patient to relax his neck, and not to resist motions imparted by the hands (Fig. 295). The eye is approached to the tip in such a way that the attractive force will be exactly in line with the track of the foreign body. If no rheostat is employed, the eye is brought within 4 or 5 inches of the magnet; when the rheostat is used, the eye is brought up till its wound is about in contact with the tip, and the aid at the rheostat is told to turn on a few ampères—the milder the draw with which the foreign body comes, the better. If here is no result, the current is turned on or the eye approached more and more, till the full capaci y of the magnet is reached. There still being no result, one proceeds to jerk at the foreign body by making and breaking the current in quick succession; and, failing in this, sidewise pulls are given to loosen the metal. Should the patient wince or speak of pain in the eye, the pull is at once changed to the original direction. When the foreign body presents at the opening its delivery may have to be helped by separating the lips or with the forceps. A sharp lookout is kept for the appearance of the foreign body, especially for a very minute one that may have attached itself to the tip of the magnet, so as not to drop and lose it by breaking the circuit. All these procedures having proved fruitless, one is not justified is giving up completely, but should, after a wait of some hours or a day, make a second effort; even after that, a third. Haab relates instances where he made trials on several days in succession, then succeeded. Between whiles, a great deal might be gained by localization.

If the scleral route is decided upon as the way out for the foreign body, irrespective of the preexistence of a scleral wound, the steps are about the same as those detailed for the small magnet, *except that no sort of extension point is inserted at the opening*. With proper localization and a powerful magnet, such as the giant is supposed to be, contact of the tip with the outer lips of the incision should be the limit.

Drawing the Foreign Body from the Vitreous into the Anter or Chamber.—When no scleral opening exists, and the foreign body is not too large, the stronger partisans of the giant magnet advocate this, then extracting through a corneal incision rather than removal directly from the vitreous by means of a scleral in-

cision. Here, if the foreign body is in the posterior segment, the tip of the magnet is applied to the summit of the cornea, so that, in coming forward, it will not engage in the ciliary body. A piece of metal once caught in the soft corrugations there, either primarily or secondarily—especially if it is sharp and angular—is most difficult to extricate. If the lens is already much wounded or cataractous, the attraction may be kept up, as begun, until the foreign body is seen to enter the anterior chamber. If, on the other hand, the crystalline seems normal or but little injured, as soon as there has been any evidence of advancement on the part of the foreign body or it has come up behind the back surface of the lens, the direction of the attraction is shifted to a point near the limbus so as to cause the metal to travel around by the zonule. Now, one must watch closely for any bulging forward of the iris produced by the foreign body. The impact against this sensitive membrane is often first made known by a sudden move by the patient. The current is instantly shut off and tip changed to the opposite side, in order to make the foreign body pass through the pupil. To have the latter dilated facilitates this step. If any special difficulties seem to lie in the way of getting the foreign body readily through the pupil, it were better to make an iridectomy just over the point where the foreign body lies in the posterior chamber. Once landed in the anterior chamber, the metal is dealt with according to the rules already given.

Loosening.—When the foreign body is fast in any of the tunics of the globe or is densely encapsuled, the chances of getting it with even the most powerful magnet are greatly lessened. A valuable office filled by the big magnet in these cases is the loosening of the metal. When possible, its exact location is ascertained beforehand. The patient is placed on a stool in front of the magnet, and the tip is applied to the globe or approached close to it, in the immediate vicinity of the foreign body, in such a way as to pull it sidewise. Every means must be used to obtain the full strength of the magnet. And it may be necessary to go all around the foreign body, pulling from every point; shutting the current off and on in quick succession now and again. The patient is instructed to be on the alert for any sensation indicative of movement on the part of the foreign body, such as a jar or vibration, a flash of light, or a pain in the eye, and

to tell of it at once. A change having been felt, before the foreign body could be intelligently extracted it might be necessary to relocate it. If this could be done with the ophthalmoscope, so much the better. Certainly, before thinking of a scleral incision through which to extract, localization should be essential. Were the foreign body situated in the ciliary body or in the root of the iris, to draw it forward might only make matters worse, and to cut down upon it under these conditions at once would hardly be proper. The preferable way would be to draw it first backward, and, if possible, slightly inward, that is, with respect to the center of the vitreous. When practicable, this should be done on that side of the sclera adjacent to the foreign body. Having moved it, relocation or not, and removal according to one of the approved methods. It is well, always to remember that success depends in great measure upon localization. If, on the contrary, the foreign body refused to budge, then one need not hesitate to make incision over it and to attempt its extraction with one or both of the magnets and, if need be, with the aid of probe and forceps. The fact that the cut would lie in the ciliary zone need no longer be a bar.

Relative Merits of Small and Large Magnets.—To a considerable extent the impression seems to prevail that, as regards this subject, ophthalmic surgeons are divided into two camps—one led by Hirschberg and the other by Haab. As a matter of fact, there are many who are more uncompromising in this affair than is either of the gentlemen just named. Hirschberg not only uses the large magnet when occasion requires it, but he has actually had constructed a larger one than that of Haab. And he of Zürich? Well, he often employs the hand-magnet in connection with the anterior chamber, and has been known to do so for foreign bodies behind the iris. To quote his own words: "When shall the small magnet be used? Answer: Within the bounds of the vitreous as little as possible; within those of the anterior chamber as you will." Unquestionably, each has its advantages and each its limitations, if not its drawbacks, and both are absolutely indispensable in this kind of work. None have better proven their worth than their illustrious inventors themselves—Hirschberg in more than 350 instances, Haab in more than 300.

It is certain that the small magnet is easily portable, that it is more

manageable, and now, with the more powerful model, reinforced to the utmost, a lifting capacity can be obtained that almost makes it equal to some of the so-called "giants." In a case of recent foreign body in the vitreous the hand-magnet has been able to draw the metal through the lens and into the anterior chamber; and to extract one through a scleral opening without letting the tip come in contact with the globe. Again, there have been cases where neither the sideroscope nor the giant magnet got any response from a foreign body in the vitreous, yet it was extracted by the small magnet through a scleral incision. It may be pretty safely asserted that most authorities are decidedly against drawing the foreign bodies from the vitreous into the anterior chamber unless the wound of entrance has been through the cornea. And Mayweg, who is recognized as an impartial as well as an able critic, has compiled careful statistics tending to prove that the scleral route, with incision, gives the best results even with the giant magnet. It would seem, then, that the fault of the scleral route did not lie with the incision. With what is it? Probably insufficient localization, disregard of the vitreous, etc.

The great distinctive feature of the giant magnet is that it has a drawing power far in excess of that of the hand-magnet, thus permitting extraction from without; and not, as has been so generally asserted, the fact that it does not necessitate *further* opening of the globe. This same power has led, in some quarters, to a contempt for localization or for diagnosis as to the mere presence of a foreign body, the claim being that if one is present, there is a good chance of bringing it out—if not, no harm is done. Hirschberg declares that it is precisely that enormous strength that constitutes the danger, and condemns its employment for diagnostic purposes. He denies its efficiency in this capacity, and says that he has seen more than a dozen cases in which such trials proved negative; nevertheless, a piece of metal was located and extracted through a scleral incision in each. Hirschberg considers the large magnet useful in loosening foreign bodies that are held fast, and particularly so in removing small ones that lie in the remote parts of the vitreous chamber, as also for cases of long standing. In recent cases Haab very justly rates the importance of localization as secondary to that of quick extraction, but insists upon the value of knowing the situation of

the wound, and the track inside of the eye. When the injured eye is on the verge of panophthalmitis, every minute counts.

After all, it seems to be pretty generally conceded or implied that localization, scleral incision (if no open wound already exists), and the use of the large magnet constitute the most eligible procedures for most cases of iron or steel in the vitreous chamber. Hirschberg's "Three Principal Causes of the Insuccess of Magnet Operations" read almost like a defense of the large magnet and an accusation of the small. They are:

1. Loss of the eye from inflammatory processes after successful extraction of the foreign body.

2. Insufficient traction power in the magnet.

3. Too firm an anchorage of the metal in its bed.

He might have added:

4. Insufficient measures of localization.

It must be admitted, however, that in many instances the drawing of the metal from the vitreous into the anterior chamber and its removal thence by means of the hand magnet through an appropriate incision constitutes a most elegant and satisfactory operation.

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